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Putting the spin on wind energy: risk management issues associated with wind energy project development in Australia

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Putting the Spin on Wind Energy

Risk management issues associated with wind energy project development in Australia

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ABSTRACT

The debate on global warming is over (Stix, 2006 p24). The global community must now find ways to reduce greenhouse emissions, particularly from energy generation. Wind energy provides one of the potential solutions to generate renewable energy without creating harmful greenhouse gases.

Wind energy is the fastest growing energy generation industry globally (‘Operating wind power capacity' 2006a). This rapid growth is being driven by increasing global energy demand, commitment from governments globally to international agreements including the Kyoto Protocol (UNFCCC 1997) to reduce the emission of greenhouse gases, as well as individual country commitments to mandatory renewable energy targets. Australia, whilst being a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) commitment to reduce greenhouse gas emissions, has so far failed to ratify the Kyoto Protocol.

In Australia, wind energy development to date has been driven primarily by the development of the Mandatory Renewable Energy Target (MRET) under the *Renewable Energy (Electricity) Act* 2000. This requires a commitment to 2% of total electricity generation (9,500GW) to be derived from renewable energy sources by the year 2010 (Warwryk, undated). It is now understood, that the current federal obligation to renewable energy is now oversubscribed, and consequently the likelihood of further wind energy projects being developed is highly limited (Brazzale 2005).

External to the government commitment to renewable energy, the development of wind energy projects requires a range of inputs including, but not limited to; an understanding of the wind resource, security of land, access to suitable electricity transmission grid, a market for the electricity, access to suitable technology and a level of community support.

Whilst the literature related to project management and risk management is extensive, the literature related to the risks associated with wind energy development in Australia is limited. This research then seeks to fill a void that asks the question;

How can project managers minimise the risk associated with wind energy developments in Australia?

To investigate this research problem, comparative case study analysis was adopted as a methodology utilising a structured interview process of project managers responsible for the development of 8 Australian wind energy projects.

This research shows that the greatest risk to Australian projects is the lack of security associated with the current federal legislation and the consequent loss of market value of the power from wind energy projects. A number of additional primary and secondary risks are identified by the interview participants, and the research is able to draw out three common themes of risk management strategies. These three themes were categorised as conservatism, due diligence and proactivism.

This study contributes to the research associated with project management, risk management and wind energy development. This insight into the Australian wind energy industry provides policy makers, educators and stakeholders with information to assist in improving the political, economic and social environment for further wind energy development, in order to mitigate against further greenhouse gas emission and combat global warming.

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ABBREVIATIONS

AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
AGO	Australian Greenhouse Office
AS/NZS 4360	Australian Standards/New Zealand Standards 4360
AusWEA	Australian Wind Energy Association (pre 2006)
AusWind	Australian Wind Energy Association (post 2006)
BWEA	British Wind Energy Association
ESCOSA	Essential Services Commission of South Australia
EWEA	European Wind Energy Association
GWEC	Global Wind Energy Council
IEA	International Energy Agency
IPART	Independent Pricing and Regulatory Tribunal of NSW
NEMMCO	National Electricity Market Management Company
MRET	Mandatory Renewable Energy Target
PMBOK	Project Management Body of Knowledge
UNFCCC	United Nations Framework Convention on Climate Change

DECLARATION

I certify that the work presented in this thesis is, to the best of my knowledge and belief, original, except as acknowledged in the text and that the material has not been submitted, either in whole or in part, for a degree at this or any other university.

I also certify that to the best of my knowledge any help received in preparing this thesis, and all sources used have been acknowledged in this thesis.

Richard Finlay Jones   Date

ACKNOWLEDGMENTS

This thesis would not have been possible to produce without the continued assistance and support of a range of individuals.

First and foremost, I dedicate this work to my wife Kristin, our two children Hannah and Charlie, Grandma Kath and Grandpa Fred for without their support, assistance and great patience, this project would not have been possible. I wish to emphasise my great appreciation to my family for the opportunity to complete such a journey.

I would also like to thank my wind energy colleagues for continuing to support and guide me along my path to learning. These people include Alan Keller, Steen Stavnsbo, Bernhard Voll, Matthew Bechly, Kristy McIntyre, Dave Burbidge, Jarad Wilson, Paul Ebert, Dominique La Fontaine, and a plethora of others with whom I had contact during this process of discovery.

Of course, it is essential that I thank the participants who contributed to the interview/survey process and provided me with a variety of frank, honest and candid responses which greatly enhanced the research experience and results.

Last, and by no means least, it is important that I thank the staff and students of Southern Cross University for their inspiration and motivation. Thank you to Professor Alex Kouzmin who started me on the road to my first *epiphany* and *Eureka* moments. Thank you to the stalwards of student services, Sue and Susan who assisted me with all matters administrative. And a special thank you to Associate Professor Stewart Hase who took me under his wing, against his better judgement, and managed to create something significant from very little. Stewart’s encouragement, advice and timely feedback assisted in the continuing motivation required for such a monumental task.

1. Chapter One - Introduction

This chapter provides an overview of the research project. The background to the study is provided, with the research problem and questions suggested from the literature review outlined. A justification for the study is provided, followed by an explanation of the research methodology. The structure of the thesis is presented, outlining the key assumptions, limitations and conclusions summarised.

1.1 Background to the study

Global warming caused by the emission of greenhouse gases has been identified as one of the greatest environmental problems facing the earth (Flannery 2005). The burning of fossil fuels for energy generation has been identified as one of the major contributors of carbon dioxide emissions into the atmosphere. As a result, most developed nations have responded to this crisis by committing to emission reduction and renewable energy targets (UNFCCC 1997). The international growth of wind energy as a viable and sustainable form of electricity production has been significant ('Wind wire: Britain against nuclear' 2006, p.8), being the fastest growing form of energy generation globally.

In Australia, wind energy is still considered a new concept, despite a long history of project implementation overseas. The introduction of the Mandatory Renewable Energy Target (AGO 2000) through the Renewable Energy (Electricity) Act 2000 legislation assisted in the development of a number of wind energy projects by providing an incentive for competition against traditional coal fired electricity generation. Approximately 817 Megawatts (MW) of installed capacity now exists in Australia (Operating Wind Power Capacity 2006b) with several thousand additional MW proposed in project developments (Australian Wind Energy Association (AusWind) 2006b).

All project developments are subject to a range of risks, and this research seeks to identify, assess and mitigate the risks that exist for wind energy project developments in Australia. Understanding these risks will contribute to the body of knowledge and practice associated with project management and risk management of medium to large scale projects.

Some of the risks associated with the financing of wind energy project developments have been documented (Raftery, Tindal & Garrad 1999), however, there are significant gaps in the literature relating to the Australian context and the present investment environment.

Some research has been carried out investigating the taxonomy of risk management strategies (Floricel & Miller 2001) however in general, this topic is not thoroughly covered in the literature. The research thesis presented contributes to an understanding of the taxonomy of risk management strategies adopted by wind energy developers in Australia

This research project addresses this gap in the literature pertaining to wind energy in particular by investigating the main risks associated with wind energy development through literature review combined with cross case analysis of eight Australian wind energy projects. In addition it was hoped that some contribution might be made to the general risk management literature.

1.2 Statement of the research problem and research questions

The preceding section provided a background to the research project and identified some gaps in the literature identified. The research problem of this study can be expressed as:

> *'How can risk be minimised during the management of wind energy project development? '*

Put another way the research seeks to; *identify, assess and minimise the risks associated with the development of wind energy projects in Australia*.

A number of sub-questions were derived from the main question:

- *What are the main risks associated with wind energy development in Australia?*
- *How are these risks managed by the organisation?*
- *How are these risks ranked relative to each other?*
- *What other risks exist that are important?*
- *What are the approaches adopted to reduce these risks?*
- *What type of risk management strategies are adopted by project developers?*

- *What are the future risks for the industry?*
- *How should these future risks be addressed?*

These research questions provide the framework for the data collection process and the ability for cross case analysis of case studies.

1.3 Justification for the study

This study addressed an important gap in the literature by focusing on the risk management function attached to a variety of wind energy projects in Australia. The existing literature provided a great deal of information on the project management and risk management processes and functions. However the literature provided more limited information on the risk associated with the financing of wind energy projects (Raftery, Tindal & Garrad 1999) and the risks associated with large offshore wind energy projects (International Energy Agency (IEA) 2005).

This study seeks to contribute to policy, theory and practice. Through the research process it will be argued that the present federal legislation represents the greatest threat to the present and future development of the Australian wind energy industry. The information gained through the research project will assist in the development of a risk register of the main risk categories associated with wind energy development in Australia. This risk register will also facilitate the development of a taxonomy of risk management strategies appropriate for use within the Australian context.

This knowledge may then be used by industry practitioners, policy makers and project stakeholders to better understand the issues associated with the development of wind energy projects, the risks and the methods of mitigation. This information may also be used to streamline the project development process and reduce the risks attached to such projects.

As a target area for wind energy development, Australia has a great contribution to make in terms of reducing its dependence on the use of fossil fuel energies. Australia also has a large land area with a suitable wind resource and ample infrastructure to support such a vibrant industry. Indeed, community sentiment supports the development of such an industry in Australia (AC Nielsen, 2006).

This research then seeks to examine the risks associated with such project development to assist existing and new developers to establish a viable and sustainable industry.

1.4 Research methodology

The previous section described a justification for the research given the gaps which exist in the literature and the context of the Australian environment. This section provides a summary of the methodology adopted for the research project.

Given the paucity of literature and research about risk management in managing wind energy projects it was clear that there was a need to initially develop an in-depth understanding of the major issues involved. Hence it was decided to adopt a qualitative approach and, specifically, case study methodology.

The exploratory case study research adopted (Perry, Riege & Brown 1999; Ticehurst & Veal 2000; Yin 1994) required the selection of appropriate cases which would provide a spectrum of projects across a variety of locations, developers and scales. Given the limited number of projects currently in operation within Australia, the projects selected were designed to provide the research with a wide variety of issues and risks for analysis.

Project managers from the eight sample projects selected were interviewed using a structured process combining both exploratory and closed questioning techniques. The data collected was combined with information from company reports and other secondary data sources to provide brief case descriptions.

Information from the interview process was then sorted and collated to provide a cross case analysis scenario. These results were then analysed and assessed to find common themes and theoretical replication through coding of particular terms and phrases. The use of prior theory (Yin 1989) was adopted where the data was compared with information collected from the literature review phase, using case research for the deductive process to confirm or disconfirm the theory

Chapter Three provides a more detailed description of the research methodology used in this research project and how it was applied to answer the research questions.

1.5 Limitations and delimitations

This research project utilises a range of literature from a variety of sources. Whilst the wind energy industry is well developed in locations such as Denmark and the US, in Australia it is considered a relatively juvenile industry. Consequently the literature sources are wide and varied. The most prevalent source of literature referenced for the latest information for the study was from the periodical magazine WindPower Monthly News Magazine, a Danish-based publication which is the only international magazine specialising in wind energy information, and ReFocus, a regular *Elsevier* publication devoted to the renewable energy sector. The data obtained from these publications, whilst being industry standards, also present some inherent biases and prejudices in favour of the industry. This does not present a problem for the research project, however, due to its geographic specificity, local flavour and focus on the risk issues.

Given the relatively small scale of the Australian wind energy industry and the limited number of completed projects in Australia, eight projects were selected for this study. Naturally, a case study approach such as this means that the findings cannot be generalised beyond the cases studied. However, attempts were made to ensure a high level of rigor in the research that would inform risk management in wind energy projects in Australia. Thus, cases were selected so that they reflected a variety of projects of different sizes, in different states and developed by different companies.

No projects were selected from Victoria, since the dominant developers in that state declined to be involved in the research study, primarily due to confidentiality reasons.

The case study research methodology limitations are described in more detail in Chapters Three and Six

1.6 Outline of the thesis

This thesis is organised into six chapters in the following order. Chapter One provides an introduction to the research, the background to the study, a justification for the research and a summary of the methodology used. An outline of the research is also provided together with the limitations of the study and its conclusions.

Chapter Two provides a detailed review of the existing literature sourced with relevance to the parent disciplines of project management, risk management and the immediate discipline of wind energy development. Chapter Two also describes the gaps in the literature and introduces the research problem and questions.

Chapter Three describes a detailed justification and description of the methodology adopted for the research project. This chapter also describes the population of cases, and the data collection and analysis procedures implemented.

Chapter Four presents the core findings of the research as well as secondary findings which emerged from the data. The categories of responses are explored and analysed to provide greater depth to the study.

Chapter Five links the findings from the literature review, to the outcomes of the research project, and provides answers for the research questions posed.

Chapter Six provides a conclusion to the research, and reviews the implications of the study for policy, practice and theory. Finally, this chapter presents the limitations of the study and identifies areas for future study.

1.7 Conclusion

This chapter has provided an overview of the thesis. It has introduced the research problem and research questions and justified the reasoning behind the research project. The methodology was described and justified, with an outline of the thesis provided. Finally the limitations and scope of the thesis were outlined. Based upon this premise, the thesis now proceeds to the subsequent chapters, commencing with a review of the relevant literature.

2 Chapter Two – Literature Review

2.1 Introduction

In the previous introductory chapter, the research project was introduced. It was identified that the impetus to reduce greenhouse gas emissions and the risks associated with climate change is driving the development of new renewable energy technologies, particularly wind. This chapter introduces the literature review through an investigation of the research documentation available on project management, risk management and wind energy development in Australia.

Climate change is now accepted as a fact by the scientific community (Flannery 2005, p.6, Stix 2006 p24), and by Australian key decision makers (Carruthers & Cornell 2005, p.24). Only 20% of Australian opinion leaders believe that concerns about global warming are exaggerated.

> *The vast majority of Australians are concerned about environmental issues and climate change, with more than half being very concerned* (AC Nielsen, 2006 p2).

The major cause of climate change is believed to be the emission of gases into the atmosphere which reflect heat back to the earth (Flannery 2005, p.26). Carbon dioxide (CO2) is considered the most significant greenhouse gas by volume and is mostly produced and increased in the atmosphere by the burning of fossil fuels such as coal, gas and oil by the human population (Flannery 2005, p.29).

Climate change has the potential to create massive threats to the survival of a great variety of species of flora and fauna (Margolis, 2006).

The use of renewable energy, especially wind energy has the potential to reduce the volumes of emissions from electricity generation. Renewable energy has been largely encouraged by government initiatives, subsidies and targets.

Historically, the Danish government has been instrumental in encouraging the development of the wind energy industry, such that now the Danish wind energy capacity is close to 20% of total generation (Halperin 2005), and at times provides 100% of generation.

Wind energy is a viable and sustainable form of renewable energy production provided that the correct mix of social, economic and environmental characteristics combine together, and are available within the local project context. The literature review seeks to identify the major research work associated with wind energy development, and identify the knowledge gaps associated with wind energy development in Australia.

Wind energy project development is one of the fastest growing industries globally. Over 66,000 megawatts (MW) of installed wind energy capacity are currently operating internationally with the majority of development located in Germany, Spain the USA and Denmark ('Operating wind power capacity' 2006b). Since 1997, Spain's wind power installations have been steadily growing at an annual rate of 30 percent (SEDO 2005), and are targeted to supply 15 percent of Spanish consumption by 2011. Germany has the highest quantity of installed capacity at close to 20,000MW ('Operating wind power capacity' 2006b).

Wind energy is perceived as a viable and sustainable alternative for energy supply in Australia. The development of wind energy projects in Australia has progressing rapidly until 2005. At present approximately 817 megawatts (MW) of installed capacity exists in Australia ('Operating wind power capacity' 2006b) with several thousand MW proposed for development (AusWEA 2005). The risks associated with new wind energy projects are varied and diverse. Consequently successful wind energy project developments require minimisation of such project risks.

Future wind energy development in Australia is largely dependent upon a potential increase in the Mandatory Renewable Energy Target (AGO 2000) from the current rate of 9,500GW, less than 2% of generation, to potentially 10% (AusWEA 2004) as well as incentives or reduced costs attached to state permitting and licencing regulations.

A further limitation to development in Australia is the sunset of the MRET at 2020, providing less than 15 years to finance potential projects.

Many other risks exist for wind developers and this research seeks to identify those risks through the production of a risk register (Raftery, Tindal & Garrad 1999, p.6). Once the risks are identified, the project will identify methods to assess or prioritise and consequently minimise their consequences.

The literature review identifies some of the major risks associated with wind energy development both internationally and in Australia, and identifies some of the gaps in the research in wind energy project management.

2.2 Background and justification for the research

The previous section introduced the literature review chapter and identified some of the key areas of discussion aligned with this research project. This section will now provide some further background and justification for this research project.

Wind energy is a rapidly growing industry globally (Operating Wind Power Capacity 2006b) and current world capacity stands at over 66,000MW of installed capacity. More than 3000MW of new wind energy projects were installed in the first half of 2005, three times the volume installed in the same period in 2004 and over 1500MW more than installed in the first six months of any other year. This activity has occurred predominantly in countries such as Germany, Spain, India and the US. Relatively little development has occurred in Australia over the same time period.

Figure 2.1 Annual wind power capacity (MW/year)

Figure removed due to copyright restrictions

Source: Global Wind Energy Council (GWEC) 2006

Annual wind power capacity is expected to grow to 1600MW per annum during 2006 as is evident by the previous growth shown in Figure 2.1 above. The graph demonstrates the rapid growth in installed wind energy capacity from 1995 to 2005.

Figure 2.2 below shows the annual installed capacity by region from 2003 to 2005 and depicts the high performance of Europe in developing wind energy projects, relative to the other regions.

Figure 2.2 Annual installed capacity by region 2003-2005

Figure removed due to copyright restrictions

Source: GWEC (2006)

Wind energy is a proven technology. Wind energy has been providing an ever increasing proportion, up to 20% of Danish energy production, for over 25 years (Gipe 1995, p.52). In the US wind energy installations began to emerge in California in the early 80s (Gipe 1995, p.30).

Wind energy is a viable and sustainable form of energy production, able to compete against traditional fossil fuel energy production, particularly where support mechanisms are in place. In many countries including Australia, renewable energy targets form the basis of the support mechanism for the industry. These targets are usually supported by a penalty placed upon a specific sector of the energy production industry for not achieving the desired target. As the costs associated with fossil fuel extraction and supply decline increase, the increasing efficiencies of wind energy will become more competitive (Gipe 1995, p.232). Australia is a mineral rich country with a high proportion of Gross Domestic Product (GDP) derived from the export of energy-rich minerals such as coal. Political and economic pressure will therefore dictate the extent to which Australia will support the development of wind energy locally.

Figure 2.3 Graph of expected distribution of wind power by region in 2025

Figure removed due to copyright restrictions

Source: BTM Consult (2005)

The development of wind energy in the future is expected to increase dramatically (BTM Consult 2005) as shown in Figure 2.3 above. Cumulative capacity is expected to increase from 48,000 MW in 2004, to 271,512 MW in 2015. This represents a forecast growth in annual installation of 13.5% per annum and an average growth in cumulative installation of 17.1% per annum. The fastest growing regions are expected to be USA, China and India.

In the US, General Electric (GE) the large energy utility, is now recognised as the market leader and is providing more than 60 per cent of the 2500 MW of wind energy capacity expected to be installed in the US in 2005(Halperin 2005). At the time of writing the US wind capacity will power approximately 10,600MW ('Operating wind power capacity' 2006b)., enough to power 2.5 million homes.

The Viridis Clean Energy Group listed on the Australian Stock Exchange in September 2005 after raising $126 million in its initial public offering (Hall 2005). Since then Viridis has invested $63.2 million on three German wind farms, rather than purchase any interest in Australian wind farms. (Hall 2005).

The Australian-based investment company Babcock and Brown recently purchased one of the largest independent renewable energy companies in Europe for Euro 490 million (Refocus 2005). Babcock and Brown acquired 100% of the issued share capital of Enersis II SGPS, which is a developer of wind and hydroelectric projects in Portugal, Spain and France. Yet, Babcock and Brown, whilst developing a small number of wind projects in Australia is not as confident to develop such similar scale projects in its home country.

Wind energy is viable where the appropriate mix of resources and infrastructure exist, combined with a competitive environment for other fuel sources. Australia possesses a unique mix of resources, skills and a suitable social environment for wind development. Australia also has the necessary physical, financial and environmental conditions required for development of large scale wind energy facilities. So why has wind energy development in Australia been so slow to develop? The answer to this question lies in the elements of risk attached to wind energy project development in this country.

In this section an overview of the rate of development of international wind energy installation was described, with emphasis on the relatively poor performance of the Australian development sector. The next section will explore the theoretical basis of this research project and seek to understand the parent disciplines associated with this study.

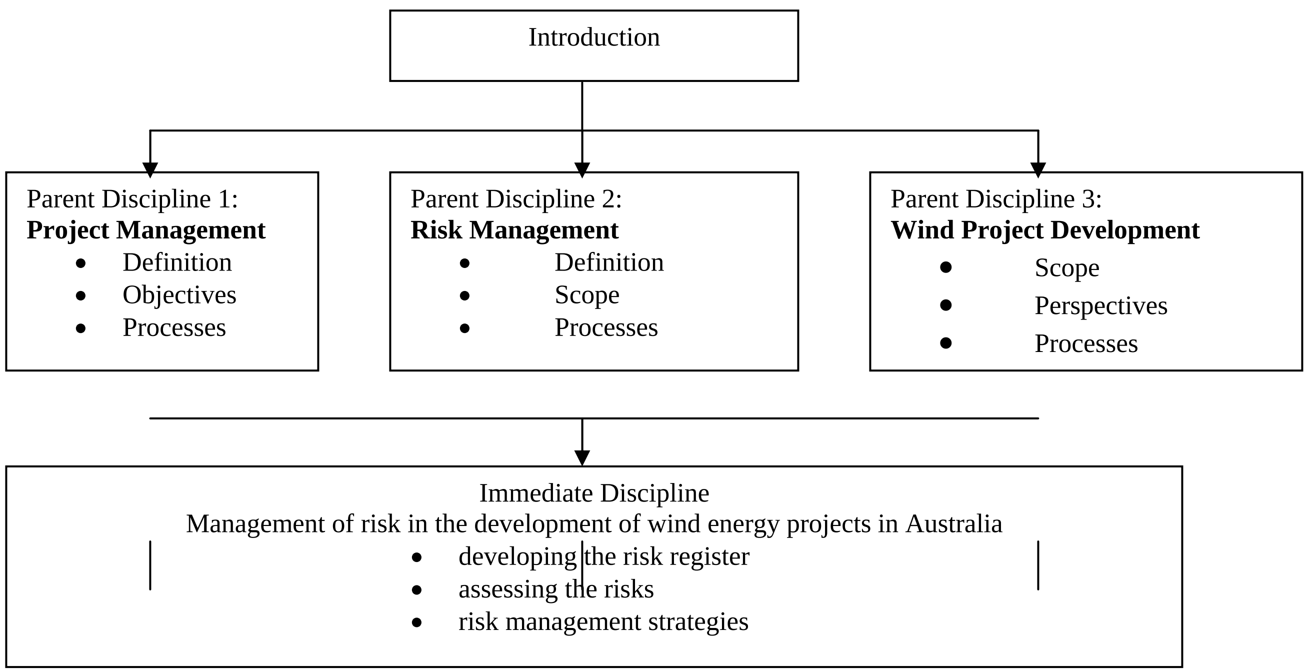
2.3 The parent disciplines

In the previous section a background to the international wind energy industry was provided, with some questions raised as to why the level of wind energy development in Australia has not kept pace with the rest of the world. This section will seek to explore the three main parent disciplines associated with this research project, namely project management, risk management and wind energy project development.

2.3.1 The concept map

The concept map identifies the main parent disciplines of the research relative to the immediate discipline. The concept map for this research project comprises the following components:

Figure 2.4 Concept map of the literature review



Source: Developed for the research

The three parent disciplines of project management, risk management and wind energy project development will be explored individually.

2.3.2 Parent discipline 1: Project management

The first parent discipline relating to this research lies within the area of project management. This section of the literature review seeks to provide an overview of the present state of research within the field of knowledge known as project management as it relates to this research. A significant body of knowledge exists for literature within the sphere of project management. This section will seek to define and describe the goals, objectives and strategies of effective project management. The next section will provide for a range of definitions in order to set the scene for the parent discipline of project management.

2.3.2.1 What is a project?

In this section we seek to understand the definition of a project, through a range of definitions proposed by international standards. This is important as a means of understanding the industry terminology and standardising perspectives on project management.

The International Standards Organisation defines a project as:

> *a set of co-ordinated activities, with a specific start and finish, pursuing a specific goal with constraints on time, cost and resources* (ISO 9001 2000, p.3).

This definition emphasises the need to manage the activities to optimise the output with limited resources.

According to Wikipedia (2006):

> *A project is a temporary endeavour undertaken to create a unique product or service. It can also comprise an ambitious plan to define and constrain a future by limiting it to set goals and parameters. The planning, execution and monitoring of major projects sometimes involves setting up a special temporary organization, consisting of a project team and one or more work teams. A project usually needs resources.*

The Project Management Body of Knowledge (PMBOK) Guide Standard describes a project as:

> *a temporary endeavour undertaken to create a unique product, service or result* (PMBOK 2004, p.5).

According to Nokes et al. (2003, p.13), projects have some or all of the following characteristics:

- *Projects involve change: these changes may be simple of complex. The change creates value for the business or operation.*
- *Projects have an objective or end point: once the objective is achieved the project finished or a new project is created.*
- *Projects do not always have a clear path or methodology for achieving the objectives, therefore projects are more risky than day-to-day processes.*

In summary, this section purports that a project is a set of managed operations which lead toward specific products or outputs, and is constrained by time, costs and available resources. Projects also typically follow a process of development, commencing with initiation and ending with decommissioning, or starting a new project.

2.3.2.2 What is project management?

Having understood the definition of a project, this section seeks to define and describe the nature of project management.

Project management according to PMBOK (2004, p.8) is the application of knowledge, skills, tools and techniques to project activities to meet project requirements. According to Barber (2004), the purpose of project management is to maximise the success of projects. Project management guides the structuring and execution of projects and includes a strong emphasis on reducing uncertainty or risk (Nokes et al. 2003). Project management is considered a process of operations and special considerations required to reduce risk and optimise outputs. The project management function requires the management of processes and functions, as well as the management of people and personnel.

2.3.2.3 The project management process

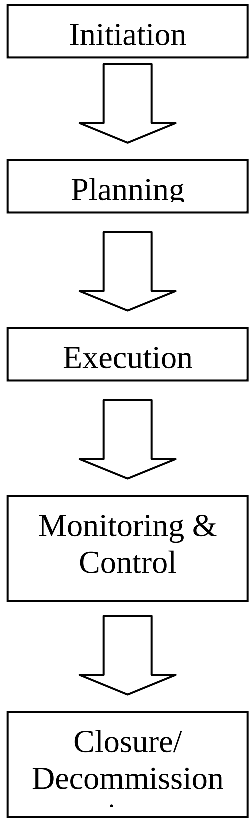
Having understood the definitions of project management, this section describes the processes and scope associated with the project management process.

According to PMBOK (2004, p.21) the project management process involves the steps of initiation, planning, executing, monitoring and controlling, and closing. These fundamental process steps are depicted below in Figure 2.5. Depending upon the nature and type of project, these steps vary in scope, risk and duration. The relevance of these steps in relation to wind energy development is explored in more depth at a later stage. Whilst the project management process depicted describes the various steps in a total project management life cycle, it may also represent the steps involved in the first phase of the development process of a wind energy project.

It is possible to compare these stages of initiation, planning, execution, monitoring and control, and finally, closure to the elements associated with the site assessment, land security, wind monitoring, feasibility assessment leading to financial close or project rejection. All of these steps may take place before a decision to actually move to construction of a wind energy project is taken.

Since this research focuses predominantly on the development aspects of the project management function, the more important elements of the process for this study, are those which contribute prior to the construction or commissioning phase of the life cycle.

Figure 2.5 The project management process

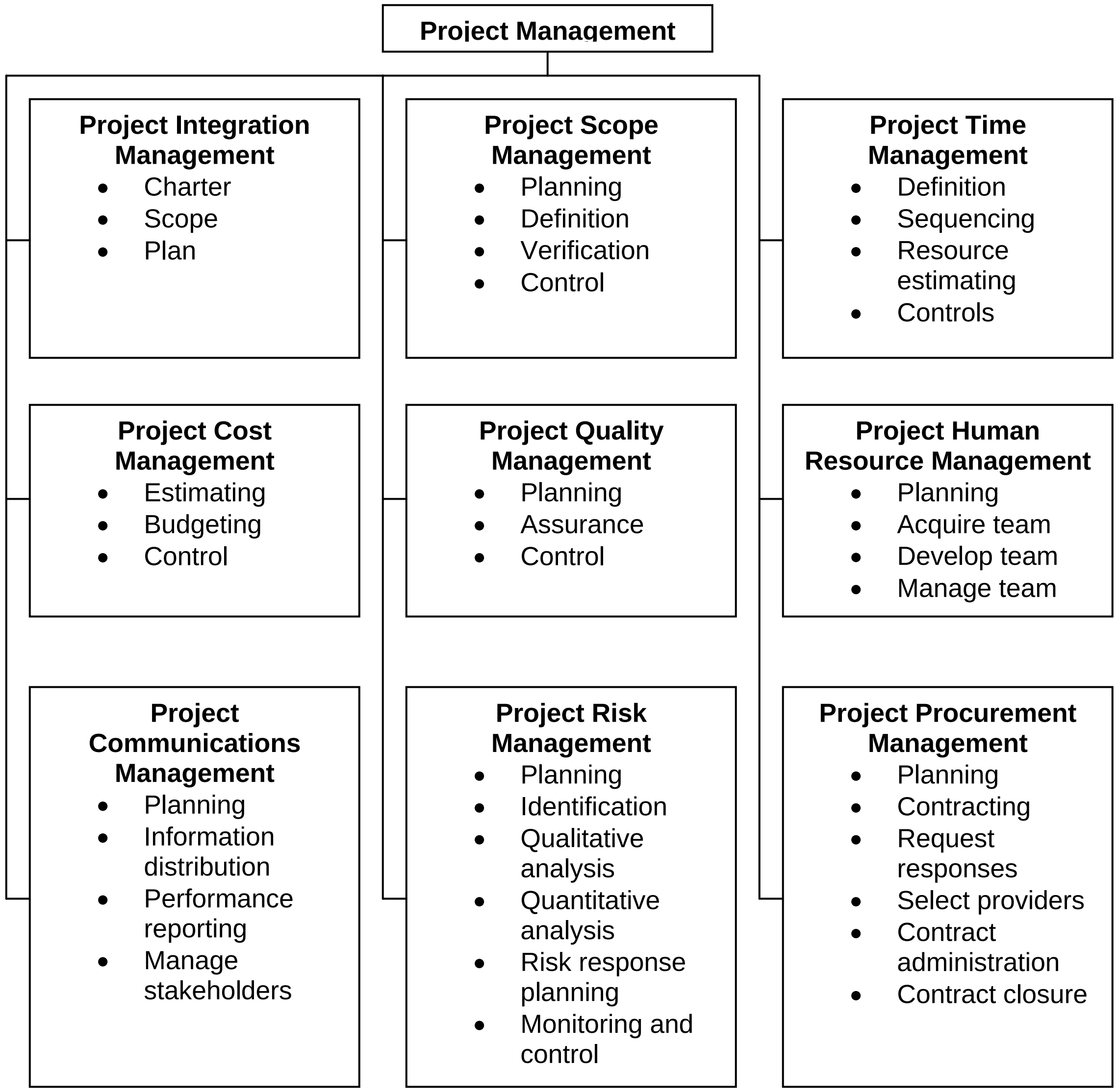


Source: Adapted for this research from PMBOK (2004)

2.3.2.4 Project management knowledge areas

The key areas of project knowledge (PMBOK 2004, p.11) include project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communications management, project risk management and project procurement management. These nine recognised knowledge areas are depicted in Figure 2.6 below.

Figure 2.6 Overview of project management knowledge areas



Source: Adapted from PMBOK (2004, p.11)

Project integration management describes the processes and activities that integrate the various elements of project management. Project scope management describes the processes involved in ensuring that all work required is included to complete the project successfully. Project time management describes the processes required to complete timely implementation of the project. Project cost management describes the processes involved in planning, estimating, budgeting and controlling costs, so that the project is completed within the approved budget. Project quality management describes the processes involved in assuring that the project will satisfy the objectives for which it was undertaken. Project human resource management describes the processes that organise and manage the project team. Project communications management describes the processes involved in the timely generation, collection, dissemination, storage and ultimate disposition of project information. Project risk management describes the processes involved in conducting risk management on a project. Project procurement management describes the processes required to facilitate the purchase or acquisition of products, services or results, as well as contract management processes (PMBOK 2004, p.10-11).

According to Nokes et al. (2003, p.15), the project management process also comprises the elements of risk management, scope management, monitoring and control, planning, administration and organisation. This section will now explore each of these elements in turn to better understand the project management process.

2.3.2.5 Risk management

Risk Management is discussed in greater detail in the section entitled Parent Discipline 2: Risk Management, however is introduced here for the purposes of emphasising the high level of risk associated with project management in comparison to normal day-to-day tasks. The risks associated with most projects may be managed if appropriate techniques are used.

Typical sources of risks include business risks, project risks and task risks (Nokes et al. 2003, p.122). These risks will now be explored in turn to provide an introduction to the risk management issues.

Business risks

Business risks may include (Nokes et al. 2003, p.123) changes to normal or typical market conditions, competitive investment opportunities, constraints on business activity for legal regulatory or environmental reasons, potential market misjudgement and negative public opinion.

Project risks

Project risks relate to the specific project rather than to activities. Such examples of project risk include (Nokes et al. 2003, p.123) user acceptance risk, security and confidentiality, management support and advocacy, missing tasks or hidden dependencies, failure of subcontractors to deliver satisfactorily, uncertainty about user requirements, mismatch between skills required and workers available, technology risk, lack of relevant experience executing similar projects, personality clashes within the team, innovation uncertainty, timescale risk, project cost risk and output quality risk

Task risks

Task risk (Nokes et al. 2003, p.124) is associated with the delivery of each activity and reflects the issues associated with project risks listed above on a micro-scale. Typically task risks relate to cost, timescale or quality.

2.3.2.6 The risk management process

Having looked at the broad categories of risks associated with project management, the next section investigates the nature of the risk management process. According to Nokes et al. (2003, p.122) the most efficient way to get risk management into the core of the project is during the initial project planning work.

The risk assessment process then involves:

- producing a ranked list of identifiable risks or risk register
- ranking each risk in terms of *severity* where severity is the product of likelihood and impact
- assigning responsibility of risks to team members and project managers

- suggesting solutions and appropriate actions to potential risks
- including risk mitigation strategies into the project plan
- reviewing the risk strategy regularly.

The risk management process is discussed in more detail in the second parent discipline section.

2.3.2.7 Scope management

Scope management refers to the need to manage the terms of reference or the project objectives to ensure that the project stays on track. Scope creep refers to the process of adjustment of a proposed project to encompass more or less of the originally agreed objectives. Typically, scope creep refers to the process of increasing the objectives of the project, and increasing the time, resources and costs compared to the original project. Scope creep can result in changes to costs, resource allocation and timing due to agreed adjustments. Reducing project scope is often a mechanism for controlling the timeframe and costs associated with project development. It is the role of the project manager to minimise scope creep whilst ensuring the satisfaction of the end users and stakeholders to the project objectives. All members of the project team should hold some responsibility to retain the project objectives and directions as specified in the original project initiation document (PID) and not amend these objectives unless through agreement with all stakeholder and investor interests.

2.3.2.8 Monitoring and control

The elements of the project management process that require monitoring and control include time, resources and funds. The project manager must therefore determine what information is required to adequately monitor tasks and activities, and what systems require implementation for satisfactory control over resource allocation.

Project reporting is typically carried out weekly, monthly and according to specific milestones. The project status report (PSR) is a document that usually summarises the history and current status of the project. The PSR reflects the status of the project in comparison to the proposed project plan, in terms of timing, costs and utilisation of resources.

2.3.2.9 Planning

Project planning involves the allocation of resources, people and funds to a timetable of operations and activities to ensure that objectives are met and milestones are achieved.

A plan is a description of how an objective will be achieved, and typically involves a narrative or graphical summary of events leading to completion. Plans may be broad or specific depending upon the need and the nature of the project. Generally the level of planning is dictated by the need to communicate the plan to various stakeholders.

Plans usually describe *activities* or *tasks,* which achieve *deliverables,* where the deliverable is the output or product. The time required to fulfil a task is termed the *task duration*, which may be *fixed* or *variable*. Plans also describe the use of *resources,* which relates to the *people, infrastructure* and *equipment* required to fulfil the task.

Typical planning tools for project management include work breakdown structures, Gantt and project timeline charts. These tools allow graphical descriptions of tasks and activities according to timeframes and budgets. Network diagrams and Project Evaluation and Review Techniques (PERT) are also graphical representations of project structure, in terms of dependencies and groupings of tasks. These planning tools are available as commercial software applications, most of which are able to graphically display network diagrams and Gantt charts.

2.3.2.10 Administration

The administration process requires the day-to-day record keeping, running of meetings and reporting. Correct daily administration will reduce the time required for further follow-up and reduces the risk of wasted time. Typically the administration function will involve monitoring of time and expenses, organisation of meetings, recording and filing of project related information, document control and resource purchasing.

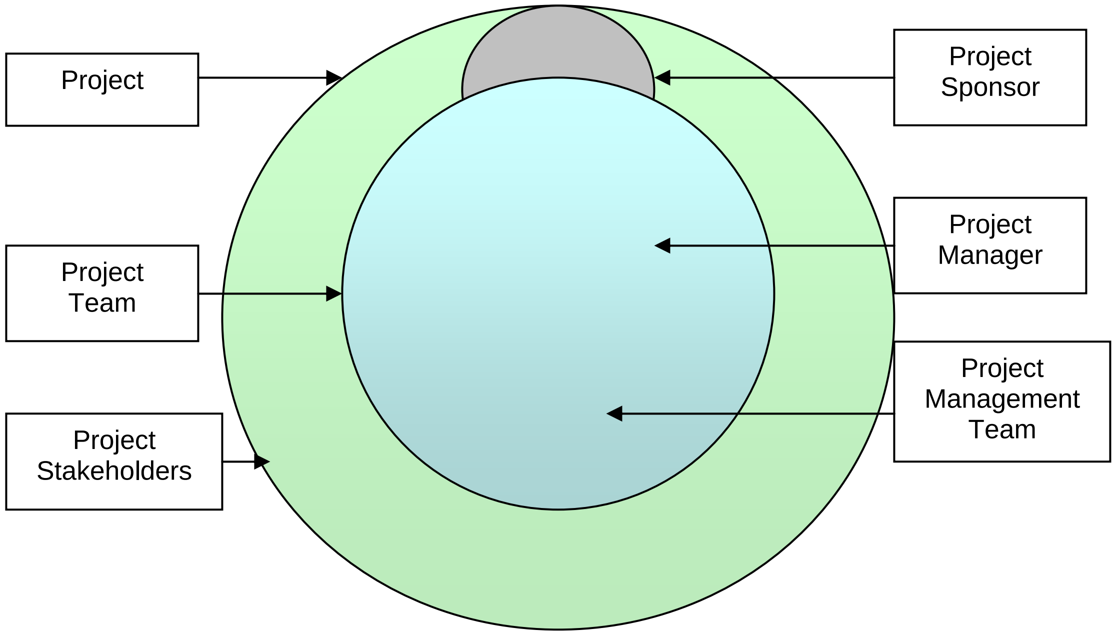
2.3.2.11 Organisation and team

Organisation refers to the arrangements of operations, teams and responsibilities, both internally and externally.

2.3.2.12 Project roles

Managing projects successfully involves managing people who are required to take responsibility for tasks being achieved toward the project goals. The variety of project roles involved in a project, include sponsor, project manager, team members, project or programme board, support office, stakeholders, specialist advisors, external suppliers, end-users and customers.

Figure 2.7 The relationship between stakeholders and the project



Source: Adapted for this research from PMBOK (2004, p.25)

Each of the project roles is now described briefly in order to define the significance and variety of each of the roles.

Sponsor

The project sponsor is usually a senior manager or project director, who assumes the ultimate financial responsibility for the project, but will usually have little to do with day-to-day operations. The project sponsor may also represent a client or end user within the project organisation. The project sponsor usually requires regular feedback on the progress of the project according to designated milestones.

Project manager

The project manager is responsible for the overall planning and delivery of the project according to an agreed process and budget, and may take direct responsibility for a number of the phases in the project lifecycle.

Programme board

A programme is defined as a number of coordinated and/or concurrent projects. It is the responsibility of the programme board to review, approve and prioritise projects (Nokes et al. 2003), as well as authorise expenditure and resource allocation.

The support office

Often a support office will exist to assist daily administration functions and coordination of resources for the project and project manager. The function of the support office may be administrative, technical, or coordinatory depending upon the organisation and the projects.

Stakeholders

Stakeholders may be internal or external and may include end-users, federal, state, of local government representatives, team members, community members, suppliers and advisors.

Specialist advisors

Technical specialists provide information, skills and knowledge to the project without the requirement for permanent inclusion in the project team. Use of specialist advisors must be adequately budgeted and scheduled.

End-users and end-user representatives

The end users may be the ultimate users of the project or project products and benefits. The products or services obtained via the project usually involve a cost to the end-user that may provide an element of the funding for the project. End users may provide input during the course of the project to ensure the suitability of the project toward achieving the desired objectives.

This concludes the description of the various stakeholders and project players. The next section describes the project life cycle and its respective components.

2.3.2.13 The project life cycle

Having discussed the respective players in the project, this section describes the life cycle of a generalised project. The project life cycle can be broken down into a number of separate phases that generally apply to most projects (Nokes et al. 2003). These phases include the project definition, design, building and testing, implementation and finally review. Each of these phases are now described in turn.

Define the project

Definition of the project results from a need or an objective. The definition clarifies the objectives and the requirements for achieving the desired output. The timing, required resources and costs are estimated and this allows comparison of the outputs with the inputs to determine whether or not the project should be pursued. This process may involve the production of a Project Initiation Document (PID). The *define* component of the process may involve a *propose* phase, and a *define* phase for larger, or more risky projects.

The Project Initiation Document (PID) will include the following elements (Nokes et al. 2003):

- project, customer, end-user requirements
- identification of stakeholders
- identification and quantification of benefits
- identification of project overlaps
- preliminary feasibility studies
- preliminary project plan
- identification of project risks

Following the PID documentation, the economic assessment must be considered. This is typically assessed using a breakeven, net present value (NPV), internal rate of return (IRR), or hurdle rate. Breakeven allows for potential returns to offset all estimated costs. NPV allows interest rates to reduce the value of the project according to a nominated timeframe. IRR allows for a discount rate that sets the NPV to zero, whereas hurdle rate defines the internal rate of return required by the investor.

Design

The design phase of project development, details the components, services and processes required to build or test the project. The design phase may incorporate system design, detailed design, budgetary design and scheduling prior to moving to the build and test phase. The design phase assigns responsibilities to each of the project players to ensure accountability of activities and transparency of process.

Build and test

The build and test phase will seek to truth or prove the design according to the desired specification or output. The build and test phase may be divided into components or developed incrementally in order to structure the entire project and minimise risks prior to project implementation.

Implementation

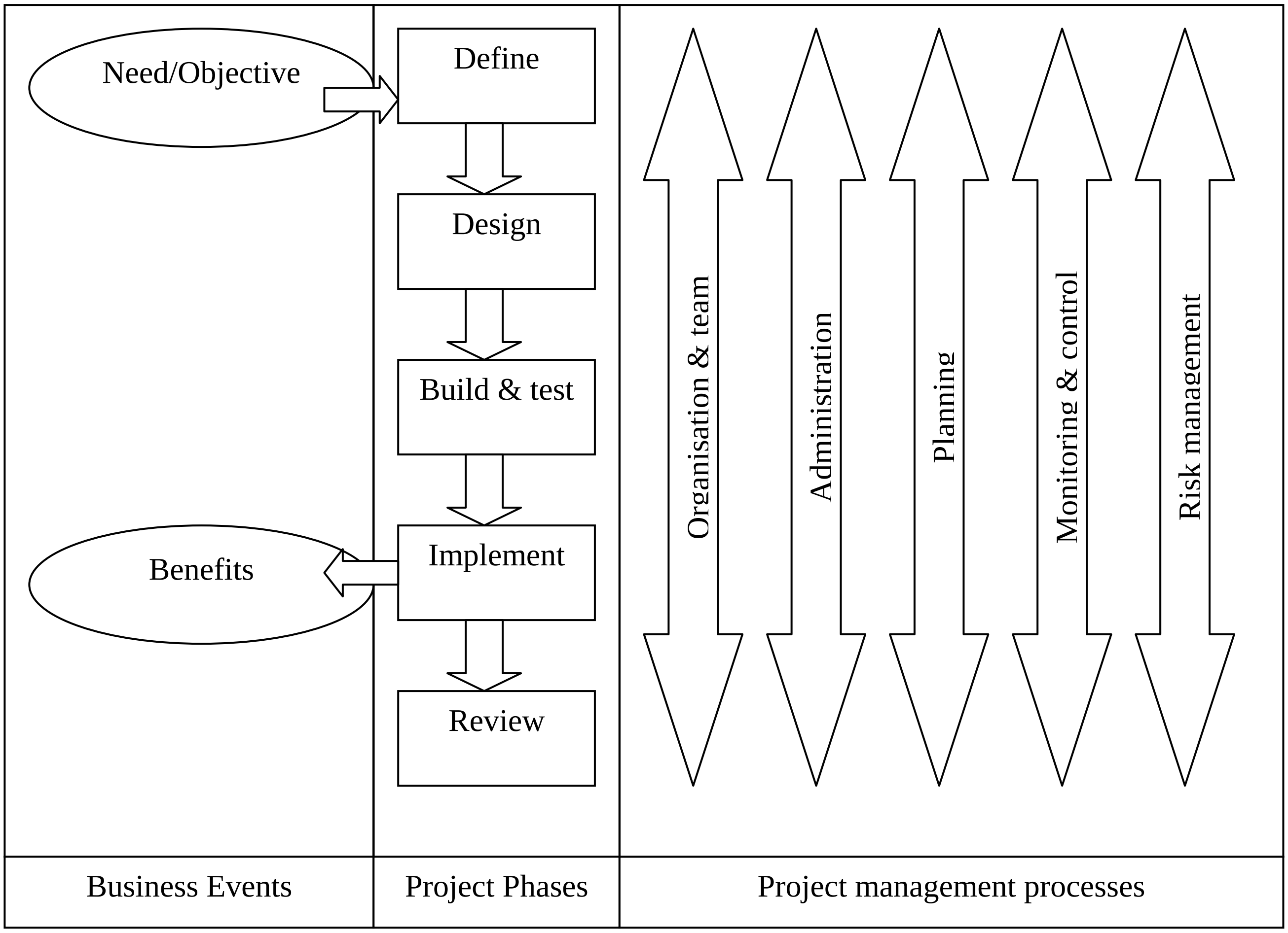
The implementation phase of project development will deliver the outcomes or products of the project. Careful planning and execution during this phase is required to minimise cost overruns, disruptions and maximise benefits. For large scale construction projects, allowance must be made for decommissioning and/or shutdown.

Review

The review process assists with the development of skills and knowledge to prevent future mistakes, errors or develop better management options for future projects. The review process may also involve monitoring of existing projects to ensure that outputs from the projects continue to be optimised.

2.3.2.14 Generic project life cycle

Figure 2.8 Generic project life cycle



Source: Adapted from Nokes et al. (2003, p.17)

The Figure 2.8 (above) depicts the flow of project phases from definition, design, build and test, implementation and review.

The diagram demonstrates the flow of processes along the timescale and the gradual development of benefits and outputs from the development process. Note the presence of risk management as a project management process on the far right.

This section has described the parent discipline of project management with an inclusive introduction to the risk management process. The next section provides a more in-depth description of risk management, which sits within the project management function.

2.3.3 Parent discipline 2: Risk management

This section of the literature review describes the parent discipline of risk management. In the previous section, the parent discipline of project management was explored, highlighting the importance of risk management as one of the critical project management processes.

To commence the discussion of risk management, it is necessary to define a number of terms which relate to risk management and the associated risk management process.

Risk management, according to the Australian Standard New Zealand Standard (AS/NZS 4360 2004, p.4) is the culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects. In this definition the environment of the risk management decision is considered as well as the potential for both positive and negative consequences.

2.3.3.1 What is risk?

The term risk is highly contested (Botterill & Mazur 2004) and has a variety of emphases and nuances, both positive and negative. The phrase risk society was originally coined by Beck (1992) with the connotation of disaster or catastrophe potentially caused by the effects of extreme industrialisation eg toxic chemicals, nuclear fallout, deforestation etc. More recently, the term has reverted to its more historical meaning of “the product of the probability and utility of some future event” (Adams 1995, p.3). Further Ballard (1992) purports that “Risk = Frequency x Consequences”, however Bernstein (1996, p.337) suggests an evolution of the perception of risk, from chance of loss into opportunity for gain, from fate and original design to sophisticated, probability-based forecasts of the future and from helplessness to choice.

More recently, Harding (1998, p.167) described risk as:

> *a combination of the probability, or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence; how often is a particular potentially harmful event going to occur [and] what are the consequences of this occurrence.*

Baccarini (2004) summarises the definition of project risk as:

> *Project risk is the chance of a future event occurring that has unfavourable affects on the project objectives.*

This definition focuses on risk having a negative effect of project outcomes, without any positive influence.

Risk is appropriately defined for the purposes of this study by AS/NZS 4360 2004 (p.3) as:

> *the chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood.*

This definition includes the concept of probability, as well as the implication of gain versus loss in management decision-making.

The PMBOK (2004, p.238) defines risk as:

> *an uncertain event or condition, that, if it occurs, has a positive or negative effect on at least one project objective, such as time cost, scope or quality*.

This examination of the definition of *risk* demonstrates the different perceptions of the term by a variety of authors, some focusing on the negative, whilst others observing a balance between positive and negative impacts.

This discussion of the definition of risk now leads into the next section which contains a definition of the risk management process.

2.3.3.2 The risk management process

Having defined risk in the previous section, the next section embarks upon a definition of risk management and a description of the risk management process. This section relies upon two main sources of literature, namely the AS/NZS 4360 2004) and the PMBOK Guide (2004).

The risk management process involves:

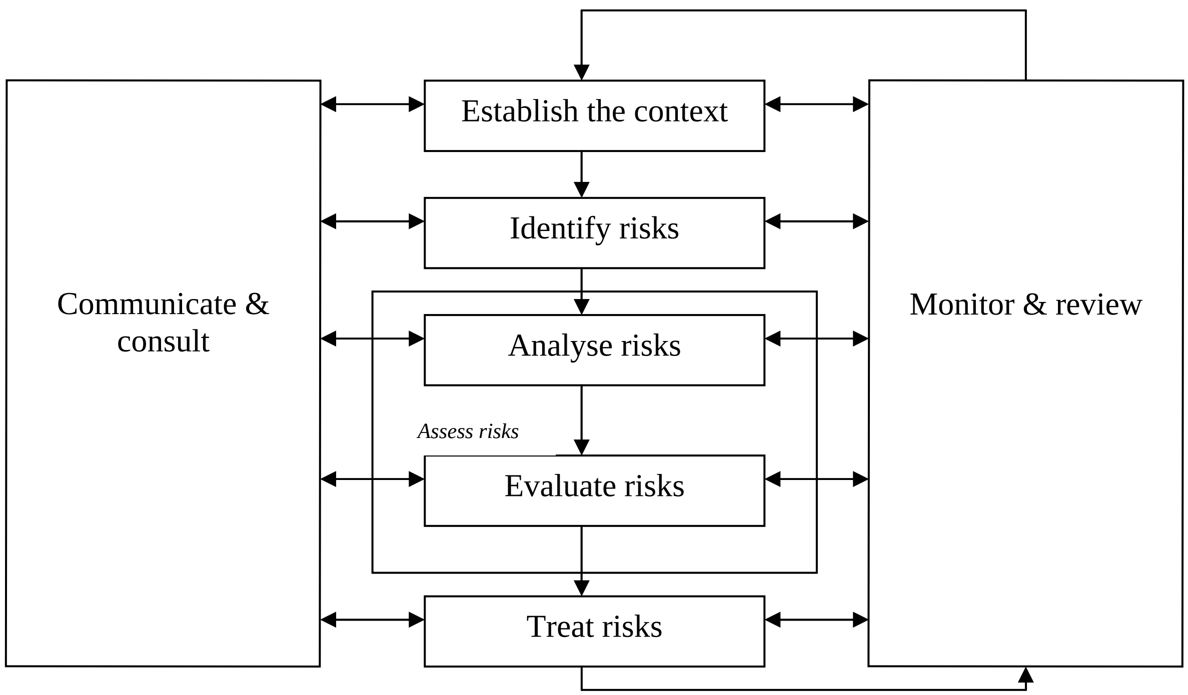
> *the systematic application of management policies, procedures and practices to the tasks of establishing the context, identifying, analysing, evaluating, treating, monitoring and communicating risk* (AS/NZS 4360 2004, p.4).

The following diagram provides an overview of the risk management process according to Standards Australia.

2.3.3.3 Risk management process overview

The risk management process according to AS/NZS 4360 2004 is as depicted in Figure 2.9 (below)

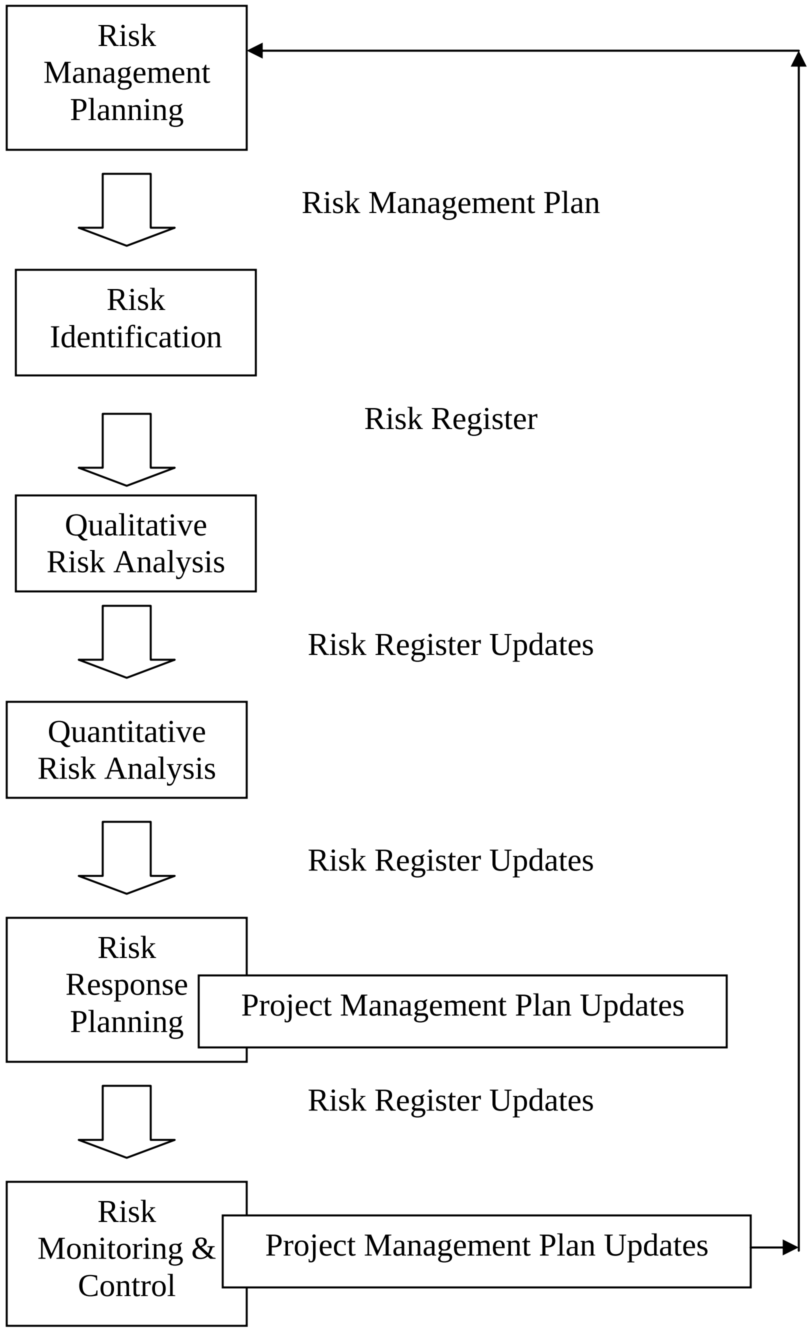
Figure 2.9 Risk management overview



Source: Adapted from AS/NZS 4360 2004 (p.8)

As an alternative risk management process model, PMBOK (2004, p.254) offers the following process flow diagram, which is more rigid in its sequence:

Figure 2.10 Project risk management process flow diagram



Source: Adapted from PMBOK (2004, p.254)

The risk management process according to AS/NZS 4360:2004 (see Figure 2.10 above) comprises the following steps:

Establish the context

The risk management process must be considered in the light of the general, strategic and organisational context.

General context

The general context defines the basic parameters within which risks must be managed and provides guidance and direction for decisions.

Establish the strategic context

The strategic context defines the relationship between the organisation and its environment, identifying the organisations strengths, weaknesses, opportunities and threats (SWOT Analysis). The strategic context includes the financial, operational, competitive, political, public perceptions, social, client, cultural and legal aspects of the organisations functions. The strategic context also identifies the internal and external stakeholders and considers their objectives, perceptions and establishes communication policies with these parties.

Establish the organisational context

The organisational context considers the organisation, its capabilities, goals, objectives and the strategies that are in place to achieve them.

Establish the risk management context

The risk management context refers to the activity, process or project to which it is being applied. The process is undertaken considering the costs, benefits and opportunities, and specifies the resources required and the records to be kept.

Setting the scope and boundaries of the risk management process involves;

a) Defining the projects or activity and establishing its goals and activities;
b) Defining the extent of the project in time and location;
c) Identifying any studies needed and their scope, objectives and resources required
d) Defining the extent and comprehensiveness of the risk management activities to be carried out.

Develop the risk evaluation criteria

The risks require determination of criteria against which they are evaluated. Such criteria include operational, technical, financial, legal, social, humanitarian or others. Criteria may be affected by internal and external perceptions and legal requirements.

Define the structure

The structure can be defined in terms of a set of elements which separate and identify the components of the activity or project.

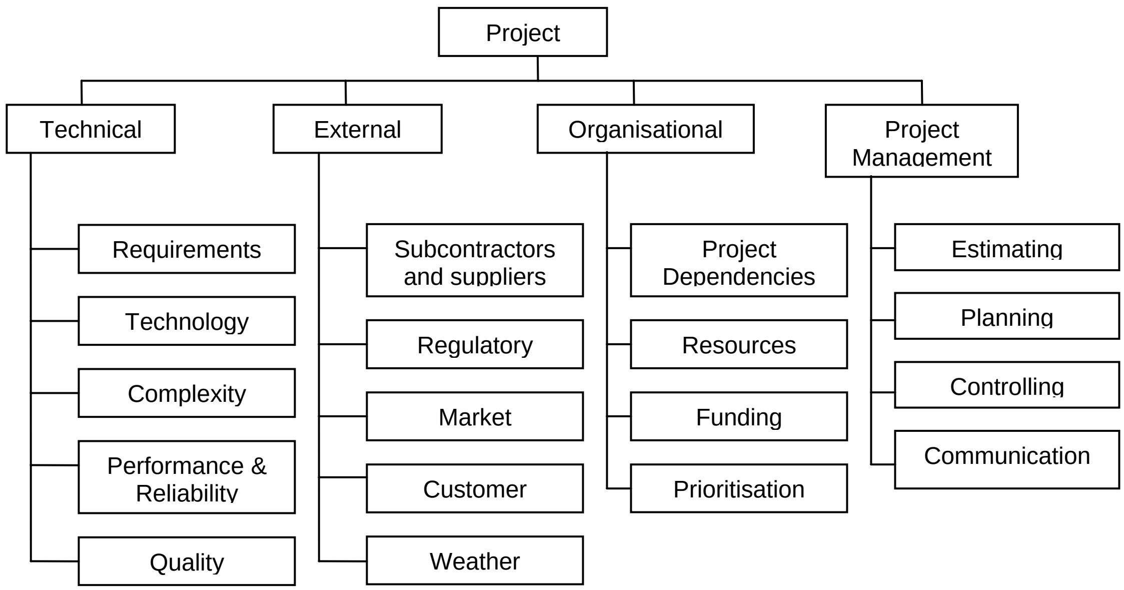
2.3.3.4 Risk identification

The risk identification process involves the systematic process of creation of a risk register. It is critical that all risks are identified irrespective of whether the risks are under the control of the organisation. Some of the risk identification tools and techniques as described by PMBOK (2004) include documentation reviews, information gathering techniques, checklist analysis, assumptions analysis, and diagramming techniques.

Information gathering techniques include brainstorming, Delphi technique, interviewing, root cause identification, and strengths, weaknesses, opportunities and threats (SWOT) analysis. Diagramming techniques include cause-and-effect diagrams, system or process flowcharts, and influence diagrams (PMBOK 2004).

The following figure lists the categories and sub-categories within which risks may arise for a typical project.

Figure 2.11 Example of a risk breakdown structure



Source: PMBOK (2004, p.244)

Following the creation of the risk register, a comprehensive list of events which might affect each element of the structure of the project, can be defined. The possible causes of risk and the likely scenarios may then be considered for the risk identification process.

2.3.3.5 Risk analysis

The risk analysis process is designed to separate the minor acceptable risks from the major risks and to provide data to assist in the evaluation of and treatment of risks. Risk analysis involves a consideration of the sources of risk, their consequences and the likelihood that those consequences may occur. The factors which affect consequences and likelihood may also be identified. Risk is analysed by combining estimates of consequences and likelihood of event in the context of existing control measures (AS/NZS 4360 2004, p.17).

Determine existing controls

The existing management, technical systems and procedures to control risk must be determined and then assessed for their strengths and weaknesses. Tools and techniques to determine existing controls may include checklists, records, flow charts, brainstorming, systems analysis, scenario analysis and systems engineering techniques. Other approaches such as inspections and control self-assessment techniques (CSA) may also be appropriate (AS/NZS 4360 2004, p.17).

Consequences and likelihood

The magnitude of the consequences of an event, should it occur, and the likelihood of the event and its associated consequences, need to be assessed in the context of the existing controls. Consequence and likelihood need to be combined to produce a particular level of risk and may be determined using statistical analysis and calculations. Alternatively where no past data are available, subjective estimates may be made which reflect the belief that a particular event or outcome will occur (AS/NZS 4360 2004, p.17).

Sources of information to determine risk consequences and likelihood may include the following:

a) Past records;
b) Relevant experience;
c) Industry practice and experience;
d) Relevant published literature;
e) Test marketing and marketing research;
f) Experiments and prototypes;
g) Economic, engineering or other models;
h) Specialist and expert judgements (AS/NZS 4360 2004, p.17).

Techniques to determine risk consequences and likelihood include:

i. structured interviews with experts in the area of interest;
ii. use of multi-disciplinary groups of experts;
iii. individual evaluations using questionnaires;
iv. use of computer and other modelling; and
v. use of fault trees and event trees

Wherever possible, the confidence placed on estimates of levels of risk should be included (AS/NZS 4360 2004, p.17).

2.3.3.6 Types of risk analysis

The Australian Risk Management Standard (AS/NZS 4360 2004, p.18) describes the types of analysis which may be undertaken depending upon the risk information and the data available. Analysis may be qualitative, semi-qualitative or quantitative or a combination of these depending upon the circumstances.

a) Qualitative Analysis

Qualitative analysis uses word form of descriptive scales to describe the magnitude of potential consequences and the likelihood that those consequences will occur (AS/NZS 4360 2004, p.18)

Table 2.1 Qualitative risk analysis matrix: Level of risk

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
A (almost certain)	H	H	E	E	E
B (likely)	M	H	H	E	E
C (moderate)	L	M	H	E	E
D (unlikely)	L	L	M	H	E
E (rare)	L	L	M	H	H

Legend

E: extreme risk; immediate action required

H: high risk; senior management attention required

M: moderate risk; management responsibility must be specified

L: low risk; manage by routine procedures

Source: Adapted from AS/NZS 4360 2004 (Appendix E, Table E3)

Qualitative analysis techniques such as these are employed to assess the likelihood and consequences of an action or decision. Such analysis is used (AS/NZS 4360 2004, p.18):

i. *as an initial screening activity to identify risks which require more detailed analysis;*

ii. *where the level of risk does not justify the time and effort required for a fuller analysis;*

iii. *where the numerical data are inadequate for a quantitative analysis*

b) Semi-quantitative analysis

In semi-quantitative analysis, qualitative scales such as those described above are given values. The objective is to produce a more detailed prioritisation than is usually achieved in qualitative analysis. Semi-quantitative analysis may not differentiate properly between risks, particularly when either consequences or likelihood are extreme (AS/NZS 4360 2004, p.18).

Sometimes it is appropriate to consider likelihood to be composed of two elements, usually referred to as frequency of exposure and probability.

Frequency of exposure is the extent to which a source of risk exists, and probability is the chance that when source of risk exists, consequences will follow. Caution must be exercised in situations where the relationship between the two elements is not completely independent ie where there is a strong relationship between frequency of exposure and probability (AS/NZS 4360 2004, p.18).

c) Quantitative analysis

Quantitative analysis uses numerical values for both consequences and likelihood using data from a variety of sources. The quality of the analysis depends upon the accuracy and completeness of the numerical values used. Consequences may be estimated by modelling the outcomes of an event or set of events, or by extrapolation from experimental studies or past data. Consequences may be expressed in terms of monetary, technical or human criteria. Likelihood is usually expressed as either a probability, a frequency, or a combination of exposure and probability (AS/NZS 4360 2004, p.19)

Sensitivity analysis

Since some of the estimates made in quantitative analysis are imprecise, a sensitivity analysis should be carried out to test the effect of changes in assumptions and data (AS/NZS 4360 2004, p.19).

Risk evaluation

Risk evaluation involves comparing the level of risk found during the analysis process with previously established risk criteria. The output of a risk evaluation is a prioritised list of risks for further action. Decisions made on the basis of the evaluation usually take account of the wider context of the risk and include consideration of the tolerability of the risks borne by parties other than the organisation which benefits from it. If risks do not fall into the low or acceptable risk category, they should be treated using one or more of the options considered in Risk Treatment (AS/NZS 4360 2004, p.19).

Risk Treatment

Risk treatment involves identifying the range of options for treating risk, assessing those options, preparing risk treatment plans and implementing them (AS/NZS 4360 2004, p.20).

Identifying options for risk treatment

Options for risk treatment include the following (AS/NZS 4360 2004, p.20):

a) Avoid the risk by deciding not to proceed with the activity likely to generate risk. Inappropriate risk avoidance may increase the significance of other risks.

   Risk aversion results in:

   i) decisions to avoid or ignore risks regardless of the information available and the costs incurred in treating those risks.
   ii) failure to treat risk
   iii) leaving critical choices and/or decisions up to other parties;
   iv) deferring decisions which the organisation cannot avoid; or
   v) selecting an option because it represents a potential lower risk regardless of benefits.

b) Reduce the likelihood of the occurrence
c) Reduce the consequences
d) Transfer the risk

   This involves another party or bearing or sharing some part of the risk. Mechanisms include the use of contracts, insurance arrangements and organisational structures such as partnerships and joint ventures.

   The transfer of risk to other parties, or physical transfer to other places, will reduce the risk for the original organisation, but may not diminish the overall level of risk to society.

Where risks are transferred in whole or in part, the organisation transferring the risk has acquired a new risk, in that the organisation to which the risk has been transferred, may not manage the risk effectively.

e) Retain the risk

After risks have been reduced or transferred, there may be residual risks which are retained. Plans should be put in place to manage the consequences of these risks if they should occur, including identifying a means of financing the risk. Risks can also be retained by default ie when there is a failure to identify and/or appropriately transfer or otherwise treat risks.

Reduction of consequence and likelihood may be referred to as risk control. Risk control involves determining the relative benefit of new controls in the light of the effectiveness of existing controls. Controls may involve effectiveness policies, procedures or physical changes.

Assessing risk treatment options

Options for treatment of risks should be assessed on the basis of the ability for risk reduction, and the extent for any additional benefits or opportunities to be created, taking into account risk evaluation criteria developed previously. A number of options may be considered and applied either individually or in combination (AS/NZS 4360 2004, p.21).

Selection of the most appropriate risk treatment options involves balancing the cost of implementing each option against the benefits derived from it. In general, the cost of managing risks needs to be commensurate with the benefits obtained. Where large reductions in risk may be obtained with relatively low expenditure, such options should be implemented. Further options for improvement may be uneconomic and judgement needs to be exercised as to whether they are justifiable.

Decisions should take account of the need to carefully consider rare but severe risks, which may warrant risk reduction measures that are not justifiable on strictly economic grounds. In general the adverse impact of risks should be made as low as reasonably practicable, irrespective of any absolute criteria.

If the level of risk is high, but considerable opportunities could result from taking the risk, such as the use of a new technology, then acceptance of the risk needs to be based on an assessment of the costs of risk treatment, and the costs of rectifying the potential consequences versus the opportunities afforded by taking the risk (AS/NZS 4360 2004, p.21).

In many cases it is unlikely that any one risk treatment option will be a complete solution for a particular problem. Often the organisation will benefit from substantially by a combination of options such as reducing the likelihood of risks, reducing their consequences, and transferring or retaining any residual risks. An example is the effective use of contracts, and risk financing supported by a risk reduction program.

Where the cumulative cost of implementing all risk treatments exceeds the available budget, the plan should clearly identify the priority order in which individual risk treatments should be implemented. Priority ordering can be established using various techniques, including risk ranking and cost-benefit analysis. Risk treatments which cannot be implemented within the limit of the available budget must either await the availability of further financial resources, or if for whatever reason any or all of the available treatments are considered important, a case must be made to secure additional finances.

Risk treatment options should consider how risk is perceived by affected parties and the most appropriate ways to communicate to those parties.

Preparing treatment plans

Risk treatment Plans should document how the chosen options are to be implemented (AS/NZS 4360 2004, p.22). These risk treatment plans should identify responsibilities, schedules, the expected outcome of treatments, budgeting, performance measures and the review process to be set in place.

The plan should also include a mechanism for assessing the implementation of the options against performance criteria, individual responsibilities and other objectives, and to monitor critical implementation milestones.

Implementing treatment plans

Ideally, responsibility for treatment of risk should be borne by those best able to control the risk (AS/NZS 4360 2004, p.22). Responsibilities should be agreed between the parties at the earliest possible time. The successful implementation of the risk treatment plan requires an effective management system which specifies the methods chosen, assigns responsibilities and individual accountabilities for actions, and monitors them against specified criteria. If, after treatment there is a residual risk, a decision needs to be taken as to whether to retain this risk or repeat the risk treatment process.

Monitoring and review

It is necessary to monitor risks, the effectiveness of the risk treatment plan, strategies, and the management system which is set up to control implementation. Risks and the effectiveness of control measures need to be monitored to ensure changing circumstances do not alter risk priorities. Few risks remain static (AS/NZS 4360 2004, p.22). Ongoing review is essential to ensure that the management plan remains relevant.

Factors which may affect the likelihood and consequences of an outcome may change, as may the factors which affect the suitability or cost of the various treatment options. It is therefore necessary to regularly repeat the risk management cycle. Review of the process and its components is an integral part of the risk management treatment plan.

Communication and consultation

Communication and consultation are an important consideration at each step of the risk management process. It is important to develop a communication plan for both internal and external stakeholders at the earliest stage of the process. This plan should address issues relating to both the risk itself and the process to manage it (AS/NZS 4360 2004, p.26).

Communication and consultation involve a two way dialogue between stakeholders with efforts focused on consultation rather than a one way flow of information from the decision maker to other stakeholders. Effective internal and external communication is important to ensure that those responsible for implementing risk management, and those with a vested interest understand the basis on which decisions are made and why particular actions are required.

Perceptions of risk can vary due to difference in assumptions and concepts and the needs, issues and concerns of stakeholders as they relate to the risk or the issues under discussion. Stakeholders are likely to make judgements of the acceptability of a risk based on their perception of risk. Since stakeholders can have a significant impact on the decisions made, it is important that their perceptions of risk, as well as their perceptions of benefits, be identified and documented and the underlying reasons for them understood and addressed.

Documentation

Each stage of the risk management process should be documented. Documentation should include assumptions, methods, data sources and results (AS/NZS 4360 2004, p.23).

Reasons for documentation

The reasons for documentation are as follows (AS/NZS 4360 2004, p.27):

a) to demonstrate the process is conducted properly;

b) to provide evidence of a systematic approach to risk identification and analysis;

c) to provide a record of risks and to develop the organisation's knowledge database;

d) to provide the relevant decision makers with a risk management plan for approval and subsequent implementation;

e) to provide an accountability mechanism and tool;

f) to facilitate continuing monitoring and review

g) to provide an audit trail; and

h) to share and communicate information.

Decisions concerning the extent of documentation may involve costs and benefits and should take into accounts the above factors.

2.3.3.7 Risk management within project management

This section will now explore the limitations of the AS/NZS 4360 2004 Standard as described in the previous section.

Limitations of the AS/NZS 4360 Standard

Barber (2004) argues that despite the processes outlined in the AS/NZS 4360, significant project risks are often not adequately identified, analysed or managed. Internal systemic risks may arise from the project or the host organisation and may involve organisational structure, culture and human resources.

In Barber's research of five projects, 125 non-trivial risks were identified. *In four of the projects, more than five of these risks were considered very significant or severe, yet many were not listed in project risk registers or in risk reports. Of all the internally generated risks identified, only about 36 were being managed (Barber 2004, p24).*

Barber (2004) found that the project management organisations studied were not effective at identifying risks, particularly internally generated risks. In addition, those organisations studied found difficulty in documenting internally generated risks as well as managing them. Since the AS/NZS 4360 system relies upon documentation, any *soft* risks that are difficult or subtle to identify and document may fall outside the scope of management of the Standard.

Soft risks are usually those risks which are considered difficult to identify, low in probability, low in impact and consequently low in severity or consequence (Nokes, 2003, p 127). In wind energy development, one such example may include the risk of severe storm damage during the construction process. Because the construction period is considered a relatively short time span compared to the length of the total project life, such a risk could be considered to be *soft*. However, as a recent project in Kansas, USA found out, such an event has the potential to cause damage to unsecured blades left lying in the field. This resulted in additional expense in repairs and replacement of a full blade (Broehl 2006).

In addition, the AS/NZS 4360 system deals with risks individually, each risk being treated one at a time. This makes no allowance for risks which may marry together, inter-relate, agglomerate or accumulate. There is no consideration of cumulative risk effects within the Standard or relationships between risks.

Barber (2004) identifies that successful project management organisations integrate the risk management process within standard formal and informal project management systems and structures.

2.3.3.8 Project risk management case studies

In a survey of project risk management in the Queensland construction industry Lyons and Skitmore (2004) found that:

- The use of risk management is moderate to high, with very little differences between the types, sizes and risk tolerance of the organisations.
- Risk management usage in the execution and planning stages is higher than in conceptual or termination phases.
- Risk identification and risk assessment are the most often used risk management elements ahead of risk response and risk documentation.
- Qualitative methods of risk assessment are used most frequently, ahead of quantitative and semi-qualitative methods.
- Risk reduction is the most frequently used risk response method followed by risk transfer; risk elimination and risk retention – with the use of contingencies and contractual transfer preferred over insurance.
- Project teams are the most frequent group to be used for risk analysis, ahead of in-house specialists and consultants. The level of specific risk management training within the construction project management industry is low to moderate
- The use of computers is consistently lower for risk management than for cost accounting, databases or scheduling. The recording of use of historical risk data is also low to moderate, along with the usage of such risk data on other projects.

Further, de Lemos et al. (2004, p.63) identified that *a complete risk analysis must include not only the technical factors but also a realistic assessment of environmental and social risks*. In a case study of construction of two bridges in Portugal it was found that the risks attached to the conduct of adequate environmental impact studies and social risks associated with expropriation of land were not realistically assessed nor managed, resulting in reduced project success due to increased costs, resources and time.

2.3.3.9 Organisational attitude to risk

The attitudes of organisations to risk will vary depending upon many factors including (adapted from Piney 2003):

- Financial conditions of the company
- Size and structure of the company
- Business approach; conservative to aggressive
- Project budget
- Financial and other potential strategic benefits
- Duration or time horizon
- Experience and qualifications of organisation
- Access to resources, partners and insurance

It is the organisational attitude to these risks that will determine the strategy by which to approach the risk.

2.3.3.10 A taxonomy of risk management strategies

According to Floricel and Miller (2001), project risk-management approaches can be grouped into two streams. The first is quantitative sensitivity analysis and probabilistic approaches, using scenario analysis, decision trees and influence diagrams. The second is a qualitative approach which seeks to identify events that may affect projects and then finds ways to mitigate against such risks.

Large scale construction projects, such as wind energy facilities face several classes of risks including (Floricel & Miller 2001):

- Sponsorship/development
- Market
- Social acceptability, regulatory and political
- Financial
- Execution
- Operation

Floricel and Miller (2001) identified five classes of strategies to deal with anticipated risks (see Table 2.2). These strategies are defined as information/selection, co-optation, allocation, design and action.

Information/Selection strategies refer to the gathering of information about the project and its potential merits and issues.

Co-optation strategies involve the development of *hierarchical links* with co-owners, joint-venture partners or equity investors. Resources can also be co-opted through arrangements such as contracts and agreements. *Co-optation strategies determine the number and quality of participants, the structure of links between them, and the bundle of resources, activities and decisions each one will control* (Floricel & Miller 2001, p.449).

Allocation strategies refer to the distribution of rights, responsibilities, rewards and risks apportioned to participants, through price, transfer, penalty, incentive and contractual agreement. Cost-reimbursement, cost-incentive and performance based contracts are methods used to allocate risk which are usually either internal or externalised.

Design strategies involve the use of technical, organisational, scheduling, and financial choices to reduce the likelihood and impact of risks. A design strategy might be an inclusion of a facility or infrastructure to improve and ensure efficiencies and viability of a project.

Action strategies involve the use of consultation and participation with stakeholders and shareholders to legitimise the project and its outcomes, and developing alternative courses of action to reduce risk.

Table 2.2 A taxonomy of risk strategies

Information/selection. Approaches used to gather information and shape the project concept	*Studies*: literature search, forecasts, surveys, tests, simulations, theoretical models, bureaucratic procedures *Private search*: use of personal contacts to obtain privileged information and aggressively shape a project opportunity *Relational probes*: meeting stakeholders and opponents to identify risks, eliminated unworkable options and enrich the project concept
Co-optation Approaches used to obtain the required competencies and secure access to resources	*Outreach*: extent to which independent entities are brought in *Link*: the relation established between an owner and other co-opted entities *Hierarchical*: business units and subsidiaries *Partnership*: co-owner, joint-venture, equity investment *Contractual*: contracts and other formal agreements *Engagement*: informal agreements *Alignment*: extent of task grouping under the responsibility of one entity *Choice*: type of bidding and negotiation procedure, level of specification detail
Allocation Use of contractual clauses to apportion rewards, risks and responsibilities between participants	*Responsibility*: detailed delineation of the obligations of each party and the conditions under which these are performed *Price*: contract price determination formulae, including risk-sharing, penalties and incentives *Transfer*: clauses limiting the exposure of one party in case of negative events
Design Use of project concept elements to reduce the likelihood and impacts of risks	*Technical*: inclusion of elements, overall architecture and specific solutions, performance levels *Organisational*: structure of supervision, reporting and information flows; co-ordination and conflict-resolution procedures and places *Schedule*: timing and sequence of activities *Financial*: type and timing of financial flows, payment conditions
Action Use of actions to reduce the likelihood of opposition or remove obstacles to project development	*Confrontation*: aggressive tactics such as suing and organising protests *Persuasion*: communication strategy and education of stakeholders *Exchange*: payments or other benefits to individuals and communities to compensate for inconveniences and obtain support *Legitimation*: approaches and symbolic gestures that signify probity, fairness, care and respect *Pre-emption*: taking early steps in order to signal commitment and block eventual competition or opposition or to develop alternative avenues for action

Source: Floricel and Miller (2001) p448

2.3.3.11 Megaproject risks

In the recent Megaprojects and Risk publication (Flyvbjerg, Bruzelius & Rothengatter 2003) a number of risks were discussed in relation to the development of large scale projects (Megaprojects) internationally. These risks include:

- the poor performance in terms of economy, environment and public support;
- the reduced level of community and stakeholder trust;
- massive cost overruns due to poor demand and cost estimation techniques;
- insufficient recognition of interest rate and currency exchange fluctuations;
- developer overoptimism and accountability issues;
- poor cumulative and indirect impact assessment techniques;
- limited monitoring and auditing of impacts during operations;
- the high cost of environmental protection;
- inaccurate overestimates of regional economic benefits;
- poor risk management techniques within development organisations;
- inadequate and misleading information regarding project development risks;
- under-informed and dysfunctional stakeholder and community groups;
- questionable and conflicting roles of government as developer and guardian of public interest;
- poor regulatory and development approval regimes;
- rent-seeking behaviour by special interest groups.

Recent trends demonstrate that wind energy projects are expanding in terms of installed capacity and capital cost, particularly toward offshore development, and many may be considered *megaproject* scale. The case studies demonstrated by Flyvbjerg, Bruzelius and Rothengatter (2003) provide a strong message to wind energy developers to improve risk management strategies and methodologies. These wind energy development risks will be explored in greater detail in the following section.

This section has sought to address the second Parent Discipline of risk management, particularly through the Australian Standards/New Zealand Standards 4360 (AS/NZS 4360 2004) and the PMBOK (2004). The process of risk management has been described according to these references, as well as some discussion of the limitations and restrictions associated with this process. With this in mind the next section will examine the specific Parent Discipline of risk management within the area of wind energy development in Australia.

2.3.4 Parent discipline 3: Wind energy project development

Wind energy project development risks

This section of the literature review will explore the parent discipline of wind energy development risks in the international context. It will describe the status and activities of the wind energy industry, and then proceed to the immediate discipline to describe and examine the major risks in wind energy development in Australia.

2.3.4.1 Background to the wind energy industry

Wind energy project development is one of the fastest growing industries globally. Over 66,000 megawatts (MW) of installed wind energy capacity are currently operating internationally with the majority of development located in Germany, Spain the USA and Denmark ('Operating wind power capacity' 2006b, p.70). Germany has the largest installed capacity of any country at over 19,500 MW. Since 1997, Spain’s wind power installations have been steadily growing at an annual rate of 30 percent (SEDO 2005), and are targeted to supply 15 percent of Spanish consumption by 2011.

These figures demonstrate both the capacity of a developed country to rapidly grow, establish and support a viable wind energy industry. The next section will examine the main risks associated with wind energy project development, commencing with the identification of the key risks.

2.3.4.2 Identifying the risks

Risk identification is the process of determining what can happen, why and when (AS/NZS 4360:2004 p4). For this research, the risks to be identified may occur from project initiation through project development, financial close, construction, operations and management to project decommissioning. These local project risks are influenced in turn by the country of origin, its legislation and supporting infrastructure. The main types of risks for wind energy projects can be divided into commercial, environmental and social risks and investigated at global, regional and local perspectives.

2.3.4.3 Global risks

The major global risks to development of wind energy projects currently include (Finlay-Jones 2004):

- international agreements and treaties
- substitute renewable energy technologies
- the potential increase in community dissatisfaction with wind energy
- significant changes to weather and wind patterns (global warming)
- volatility of resource markets
- relatively low prices of fossil fuels
- industrialisation combined with low environmental awareness in developing countries.

Each of these global risks will be examined in further detail in the sections below.

International agreements

One of the greatest drivers for renewable energy projects internationally are the Kyoto Protocol (UNFCCC 1997), the UNFCCC and the subsequent commitments made by individual countries to reduce greenhouse gas emissions.

Whilst the Kyoto Protocol has not yet been ratified by Australia, and appears unlikely to occur, the level of commitment by most developed countries has led to the development of international carbon trading systems and projects in Asia, South America and Europe.

These systems encourage the development of renewable energy projects in developed countries but also in developing countries through the Joint Implementation (JI) and Clean Development Mechanism (CDM) processes.

Due to the failure of Australia and the US to ratify the Kyoto Protocol, there is an element of risk that the development of renewable energy projects could be slowed in these locations. Without ratification of the Kyoto Protocol success of the existing trading systems may be jeopardised potentially devaluating renewable energy projects in Asia and South America. Despite the US not ratifying the Kyoto Protocol, it has embarked on a vigorous campaign promoting renewable energy and in particular, wind energy such that it is now the third highest developer of wind energy projects with a total installed capacity of over 10,600MW (Operating Wind Power Capacity 2006b)

Since the Kyoto Protocol has come into force in February 2005, it has created a strong market for renewable energy technologies, projects and the operation of a carbon trading scheme. At the time of writing this research, Australia and the US have failed to ratify the Kyoto Protocol and the likelihood of these countries ratifying appears to be losing momentum.

More recently (July 2005), the Asia Pacific Partnership on Clean Development and Climate has brought together the countries of Australia, USA, China, India, Japan and South Korea *to address the challenges of climate change, energy security and air pollution, in a way that strives to encourage economic development and reduce poverty* (Prime Minister of Australia 2005). This Charter was accepted at the inaugural meeting of the partners in January 2006 (Department of Foreign Affairs & Trade 2006) and a work plan determined. Under the work plan, eight task forces were established covering: (1) cleaner fossil energy; (2) renewable energy and distributed generation; (3) power generation and transmission; (4) steel; (5) aluminium; (6) cement; (7) coal mining; and (8) buildings and appliances. These task forces are to develop action plans and report back to the partnership by mid-2006.

Global energy substitution risks

Except for nuclear power, the risk of wind energy being substituted by traditional energy sources appears to be decreasing (Gipe 1995, p.3) whilst the risk of substitution by other renewable energy sources such as hydro and biomass is increasing. Nuclear energy is gaining momentum as a potential source of high volume low greenhouse energy (Kemeny 2005; Milborrow 2006, p.43) since it is being promoted as a greenhouse friendly form of mass energy production..

The decreasing risk of substitution by traditional energy sources such as coal is due to a range of factors including the decreasing cost of wind energy technology (Gipe 1995, p.226-246), the improved effectiveness and efficiency of wind energy developments and the increasing level of subsidies to other renewable energy technologies in most developed countries (Knight 2004). In more recent times and due to massive international demand, the cost of wind energy is increasing and wind turbines are becoming more difficult to obtain (Harrison 2006b, p.6)

This same increase in subsidies and incentives for wind energy is afforded to most other renewable energies in developed countries, therefore it could be argued that as wind technology developments begin to plateau, other renewable energies such as solar and biomass could become more competitive against wind generated electricity.

More recently, it is interesting to note that emphasis on cleaner coal production is the first priority task force of the Asia Pacific Partnership on Clean Development and Climate. Further, due to the strong demand for wind turbines in the USA and EU, the cost of installation of wind energy projects has recently increased, reducing the attractiveness of some wind projects.

The nuclear lobby has also found a listening ear in the debate to reduce greenhouse gas emissions, whilst still providing a large volume of energy for a dramatically expanding international energy market.

Nuclear energy has the potential to replace large volume coal fired facilities and reduce significant greenhouse gas emissions (Kemeny 2005; Milborrow 2006, p.43).

Global greenhouse gas mitigation competition risks

The development of new renewable energy industries provides for some mitigation against greenhouse gas emissions and climate change. Some technologies being developed however represent potential storage solutions for carbon dioxide. Geo-sequestration is an example of such a technology, which is being examined by governments such as Australia's, and the fossil fuel industry as a viable solution to carbon dioxide emissions. High levels of expenditure have already occurred into researching the opportunity to store carbon dioxide underground under pressure.

In Australia, the fossil fuel lobby appears to be selecting clean coal options and geo-sequestration as the *technology of choice* for the sequestration of carbon dioxide from emissions (Environment Business Australia 2004). The impact of the fossil fuel lobby on the Australian renewable energy policy in time of global warming has been described as disturbing (Hamilton 2006, p.1).

Community acceptance

One of the most serious issues facing the global wind energy industry at present is the lack of community (social) acceptance (Gipe 1995, p.250). Community acceptance of wind energy projects is in turn influenced by the size of the wind turbines, the number of turbines proposed and the potential for noise and visual impact from the turbines.

This issue is highlighted in recent Australian (The Weekend Australian, Sixty Minutes, A Current Affair) and UK media (The Daily Telegraph), where political alignment in an election climate has stimulated increased debate. Even Prince Charles, heir to the British throne is recently reported by friends to have described them as a "horrendous blot on the landscape" (Massy 2004a, p.33).

Other issues which have been demonstrated as being of significant consequence to community stakeholders include shading, flicker and electromagnetic interference from the wind turbine generators as well as environmental impacts to flora and fauna.

The difficulty associated with the community acceptance issue is predominantly a consequence of visual amenity. Visual amenity is a subjective matter, dependent upon the experience and beliefs of the individual. Surveys held with community members prior to and post construction have found that these issues tend to become less of an issue, and community acceptance for such projects increases with time (Gipe 1995, p.271).

Whilst the wind energy industry globally is growing, the visual impact of wind turbines on the landscape is inescapable, except perhaps at sea, where the majority of large scale wind energy projects are now targeted in Europe. One of the world's largest proposed offshore wind farms, known as the London Array, is 1000MW in size, comprising some 250-300 turbines (Offshore Digest 2006). Large scale offshore wind energy projects are also proposed by Ireland, The Netherlands, Norway, Sweden, France and Germany.

Significant weather changes and global warming

The current research supporting the position of the Kyoto Protocol and global warming, (Flannery 2005) indicates that changes to long term wind and weather patterns is a distinct possibility (International Institute for Sustainable Development 2000). The implications of this for the wind energy industry are many and varied and include:

- increased demand for renewable energy technologies
- reduced reliability of wind data
- increases in project risk, leading to increase in project costs

The measurement of long term wind data by indices developed in Denmark and Germany are demonstrating that the reliability of wind data collected in the past 20 years are showing results which vary from the past 140 years (Milborrow 2005).

The more recent winds appear to be less strong than those from longer term data, which means that energy production from wind facilities developed using the indices, is lower than originally forecast. This has resulted in a reduced energy output and less viable projects, in an already low wind speed country.

Availability of capital

Whilst the capital market is supporting a general increase in wind energy projects globally, competition for this limited market is also increasing. Many of the large financial institutions and fund management organisations have established renewable energy funds for the purpose of investing into projects such as wind energy developments. This funding is being directed toward larger scale, economically scaled and more efficient projects. Whilst there appears to be abundant available capital for viable wind energy projects internationally, at present the investment is occurring in the EU, US and some developing countries. There remains a level of reluctance by the investment community to participate in more high risk and expensive projects such as those within the offshore wind sector (Finlay-Jones 2004).

Volatility of resource markets

Volatility in the global financial and resource markets represents a risk to any large scale projects requiring significant capital investment from the private sector. This, in combination with the failures of large global companies such as Enron and Andersen, as well as local examples such as HIH, consumer confidence in the traditional large corporate organisations and their management is declining (Finlay-Jones 2004).

Relatively low prices of fossil fuels

Whilst the present evidence supports dramatic increases in oil prices, the relative prices of fossil fuels remain sufficiently low compared to the costs of renewable energies, in particular wind energy. Whilst fossil fuel prices remain relatively low, the incentive to move away from coal-fired power, particularly in Australia, is limited. In Kyoto compliant countries dominated by energy production from greenhouse emitting fossil fuels, the investment and growth in the wind energy sector is strong (Finlay-Jones 2004).

Developing country opportunities

Some of the largest opportunities for development of wind energy projects resides with developing countries such as India and China (Harrison 2006b). With large populations and strong potential electricity loads, combined with relatively strong wind resources and high electricity costs, these geographic markets represent the new world for renewable energy technologies.

Competition from other forms of electricity generation in these parts of the world is also strong. This, combined with a relatively low awareness of the environmental costs of many traditional forms of electricity generation presents a risk for wind energy project development globally.

The opportunities which have been presented by developing countries such a India and China have presented a number of risks for the progress of the industry in the developed countries. Due to the rapid growth of the wind industry in India and China, in combination with global demand in the developed world the cost of turbines has increased and the consequent availability diminished (Harrison 2006b, p.6).

This section has examined a number of the global risks associated with wind development. The next section will explore some the national risks which impact upon the potential growth of the sector.

2.3.4.4 National risks

The national risks associated with wind farm development are usually associated with the certainty and level of supportive legislation, incentive funding and electricity market infrastructure and reform. Each of these elements will now be examined in more detail.

National legislation

The legislative support toward wind energy is usually expressed as a penalty to generating or retailer utilities, combined with a target toward renewable energy, which is usually expressed as a percentage of total generation or a commitment to a specific installed capacity.

The US represents a good example of a country experiencing strong growth in the wind energy sector due its legislative framework and incentives. The US legislative system operates by means of the Energy Policy Act of 2005 (US Dept of Energy and Commerce 2005), which provides for production tax credits (PTC) for wind energy. This allows for an additional 1.9 cents per kilowatt hour (kWh) extended through 2007. This credit applies over the first 10 years of a project's operation and hence has facilitated strong growth in wind energy development until the end of calendar year 2007 (Smith 2005, p.45).

The wind industry in the US has called for the mandating of a federal renewable portfolio standard (RPS) of 10% of the nation's energy to be generated from renewables by 2020, however at the time of writing the US federal government has failed to adopt any mandatory renewable targets (Smith 2005, p.46).

Specific policy mechanisms

A number of examples of specific policy mechanisms favouring renewable energy can be cited. These include fixed price systems, where the government sets the electricity prices or renewable quota systems where the government sets the quantity of renewable energy produced and leaves it to the market to determine the price (GWEC 2005, p.12). Fixed price systems may also include investment subsidies, fixed feed-in tariffs, fixed premium systems and tax credits. Renewable quota systems are used in a number of countries including the UK, Sweden, Belgium and Italy usually as tendering systems (UK) or Green Certificate Systems (Belgium).

Electricity market reform

Barriers to renewable energy development exist in certain markets where the market and infrastructure has been developed around large centralised power plants and often include extensive licensing requirements and specifications for access to the transmission grid.

Such distortions and risks to wind energy include institutional and legal barriers, existence of dominant market players, limited interconnection between regional and national markets, discriminatory tariffs, no effective unbundling of production relative to transmission (GWEC 2005, p.13-14).

2.3.4.5 State and regional risks

Many of the national risks described above are also encountered at a state and regional level and represent barriers and impediments to renewable energy development.

Renewable energy incentives

Such renewable energy development incentives at the national level tend to influence the attitudes of states and provinces to set additional state-based renewable portfolio standards (RPS). For example in the US, Virginia and Wisconsin are considering setting minimum standards for the proportion of renewable energy in electricity supply portfolios (Anderson 2006, p.37) of up to 20% renewables by 2007.

Whilst these targets provide some incentive to development, the risks for project developers to consider in the light of such legislative enactments include; the duration of the incentive, the value of the incentive and the impact on any long term potential off-take agreements. Such legislation has been known to be reversed or reduced by a change in government or a massive change in community opinion.

This section has discussed the ability of federal and state legislation to influence project development. The next section will focus on the local project risks associated with wind energy development.

2.3.4.6 Local project risks

The project development process involves a range of activities commencing with land security, wind monitoring, turbine selection, grid connection, construction and finally operations and management. Each of these processes has an element of risk attached and a consequent inherent market value for each successful stage of development achieved.

According to Floricel and Miller (2001) large scale projects potentially face several classes of risks: sponsorship/development, market, social acceptability, regulatory and political, financial, execution and operation.

At a local level, there are a wide variety of risks to the success of the wind energy project. For the purposes of this research it is intended to focus on the main risk factors and their management, rather than identify each individual risk element which may vary for any given project.

Table 2.3 General classification of risks associated with wind energy projects

Risk Factor	**Subcategory**	**Risk Stakeholders**
Prospecting	*Land assessment*	*Developer*
Land Security	*Wind Monitoring Agreement*	*Landholders/Developer/Legal advisors*
	Land Lease	*Landholders/Developer/Legal advisors*
Wind Resource	*Monitoring/modelling*	*Developer/Contractors*
Feasibility Studies	*Economic modelling*	*Developer/Contractor*
Development Application	*Environmental Impact Assessment*	*Developer/Contractors*
Licensing/Permitting	*Approvals and Reporting*	*Developer/State agencies/local govt*
Grid Connection	*Study/Agreement*	*Developer/Contractor/Network Service Provider*
Power Purchase	*Power Purchase Agreement*	*Developer/Utility/Legal advisors*
Finance	*Debt*	*Developer/Institution/Legal advisors*
	Equity	*Developer/Shareholder/Institution/Legal advisors*
Construction	*Construction Agreement*	*Developer/EPC/Turbine manufacturer/Shareholders/Legal advisors*
Operation & Maintenance	*O&M Agreement*	*Turbine manufacturers/subcontractors/project entity*
Decommissioning	*Decommission Agreement*	*Project entity/Subcontractor*

Source: Finlay-Jones (2004)

The Table 2.3 (above), lists the key local risks associated with the development of a wind energy project from greenfields project identification and scoping to decommissioning. The table lists potential risk subcategories and identifies potential risk stakeholders in the process. This table does not attempt to prioritise nor sequence the risks although this may be considered a chronological process. Within each of the processes lie commercial, environmental and social risks which will now be examined in more detail.

2.4.4.7 Commercial risks

It can be argued that any risk to the project development process represents a potential commercial risk.

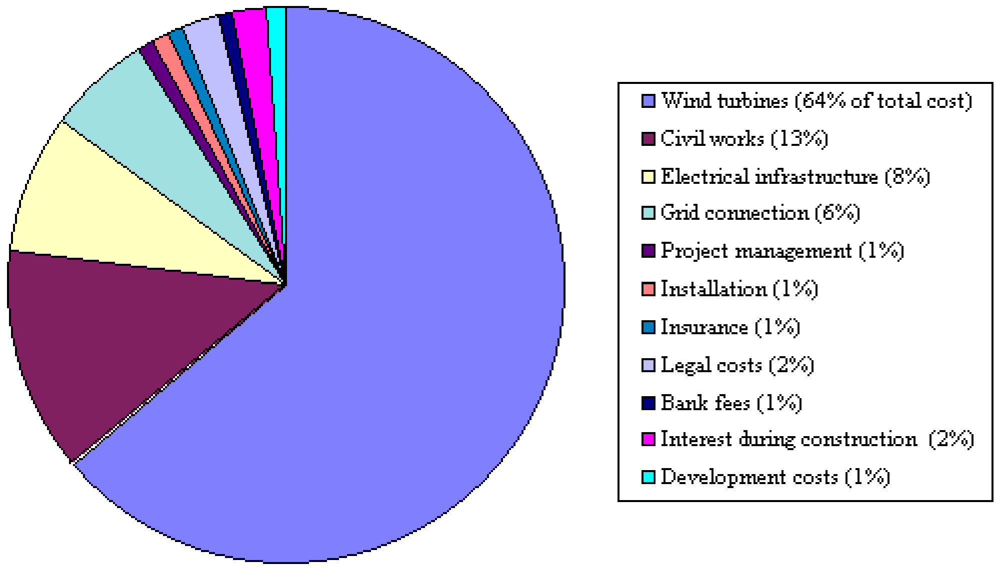
The commercial risks in any major wind development project (Raftery, Tindal & Garrad 1999, p.6) include the following:

- Sponsor/completion risk
- Technology risk
- Energy production risk
- Offtake/sales risk
- Operating risk
- Regulatory risk
- Insurance risk
- Financial risk
- Country risk

Other risks not considered in this appraisal include developer risk, design risk and environmental risks, which may also lead to commercial risk.

The capital costs (see Figure 2.12) of a wind energy project typically represent between 75-90% of the total cost of the project (British Wind Energy Association (BWEA) 1999) and are additional to the financing cost and the running costs.

Figure 2.12 The capital cost breakdown of a typical 5 MW project



Source: BWEA (1999)

Note in the figure above that these figures are from 1999 and are for a small (5MW) project.

Energy production risks

Energy production risks are typically associated with the reliability of the wind, its measurement and modelling across the terrain. There are a number of methods that may be used to forecast energy production from proposed wind farm project including proprietary and in-house software applications.

In order to minimise the risk associated with energy production forecasts the project should seek to optimise the height location and number of wind monitoring masts to reduce the uncertainty attached to (Raftery, Tindal & Garrad 1999, p.9):

- anemometer calibration
- wind speed correlation
- calculation of wind flow over the site
- wake losses
- future variability of annual wind speeds

The accuracy and reliability of the data recorded and the modelling assumptions used will reflect the energy production forecasts.

The offtake/sales risk

In order to minimise risk in the offtake/sales agreement wind energy developers should be seeking to optimise the terms of the power purchase agreement with respect to:

- energy price ie maximise the price of the power sold;
- renewable energy certificates price;
- contract duration;
- market participation (high risk) and bilateral agreement (low risk);
- financial stability (rating of the offtake provider)

Raftery, Tindal and Garrad (1999) identified that a major risk factor in the electricity sales contract was the method of indexation of the power price to the customer, relative to inflation. This will also depend upon the method by which the project is to be financed, whether by balance sheet, or by project finance.

Grid connection risks

To minimise the risk and optimise the output, the developer needs to optimise the grid connection to allow maximum penetration of energy produced and minimum grid constraints causing operational limitations. This is usually enhanced by locating wind energy projects in close proximity to appropriate transmission grid lines, which in turn are relatively close to a local load.

Site selection risks

The issue of site selection is re-emphasised here in that without careful and considered site selection with respect to factors such as wind resource, grid capacity and the availability of Power Purchase Agreements (PPAs) the risk associated with offtake and sales is exacerbated. The balance of these approaches will be determined by the developer and its approach to risk in the energy market.

Finance risk

Cashflow analysis figures undertaken by Raftery, Tindal and Garrad (1999), which considered 2 wind farms in Europe of 10 and 30MW respectively, found that the debt service coverage ratio (DCR) over the loan period of 10 years was most greatly influenced by the long term mean wind speed. This reinforces the need for developers to locate and optimise wind monitoring towers with calibrated anemometers which allow for correlation against long term wind data.

This section has sought to provide an overview of the commercial risks associated with wind energy development. The next section will examine the area of environmental risk associated with wind energy developments.

2.3.4.8 Environmental risks

Apart from providing environmental benefits in terms of renewable energy and greenhouse mitigation benefits, wind farms have the potential to impact negatively on the local environment. The key environmental impacts caused by wind farms developments include collision by bats and birds, visual amenity, noise, heritage issues, electromagnetic interference, and cumulative impacts.

Impact on flora and fauna: Bats and birds

Strong evidence exists that collision of bats and birds into wind turbines causes mortality. It is estimated that each wind turbine kills between 1 and 3 birds per year in the US (National Wind Coordinating Committee, (NWCC) 2001). The wind energy area with one of the greatest impacts on bird species would be the Altamont Pass area in Northern California where the 79 square mile, 5600 turbine area has been notified by the Alameda County to shut down varying combinations of the turbines for months at a time in an effort to assess bird mortalities (Anderson 2005, p.47). These shutdowns will cost wind turbine owners a collective US$9 million per year and at least US$120 million over the 13 year permitting period.

2.3.4.9 Social and cultural risks

Further to the discussion of cultural risk is that attached to the disenfranchisement of local communities due to the development of large scale projects.

Flyvbjerg, Bruzelius and Rothengatter (2003), argue that large projects have traditionally excluded public involvement in the project development process, and it could be argued that despite a pathway for most project development processes in Australia, that greater public involvement is required.

The methodology for achieving cost-effective and satisfactory comprehensive community consultation processes is not clear and until it is so, developers need to ensure that such risks are identified and managed appropriately.

This concludes the section describing the range of risks attached to the development of wind energy projects in general. The next section will focus on the risks associated with wind energy developments in Australia.

2.3.5 Immediate discipline: Risks in wind energy development in Australia

Wind energy is perceived as a viable and sustainable alternative for energy supply in Australia. The development of wind energy projects in Australia has progressing rapidly until 2005. At present approximately 817 megawatts (MW) of installed capacity exists in Australia with several thousand MW proposed for development (Operating Wind Power Capacity 2006b). The risks associated with new wind energy projects are varied and diverse. Consequently successful wind energy project developments require minimisation of such project risks.

At 817MW of installed capacity, Australia lags behind the rest of the developed world in terms of wind energy production, for reasons ranging from the low price of coal fired electricity to a lack of commitment from the federal government to support renewable energy.

Australia's renewable energy target is dwarfed by the efforts of countries such as the UK to achieve 10% of the countries energy generation from renewable sources by 2010 and for Europe to achieve 25% renewable energy generation by 2020 (GWEC 2006, p.24).

To ensure the achievement of successful wind energy projects in Australia requires a number of special circumstances to achieve viability and sustainability. These include a supportive federal and state government regulatory regime, competitive and supportive electricity pricing, accounting for the environmental costs of fossils fuels, and community education. The physical site factors of a suitable and adequate wind resource, supportive local communities and grid connectivity and capacity then determine the possible areas where wind energy capture can occur.

As with most large scale, high value projects, there are many risks associated with the development of wind energy projects. This section will seek to describe these risks and then localise them to the Australian context.

2.3.5.1 National risks

The national risks to development of wind energy projects vary in each country however, are dominated by the commitment or otherwise, of legislation or subsidies to encourage renewable energy projects. In Australia this can be exemplified by the Mandatory Renewable Energy Target (AGO 2000) legislation, however other local risks may include such factors as suitable and available land, and adequate wind resource and infrastructure to support such projects, including roading, site accessibility and proximity to an appropriate electricity grid.

National legislation

In Australia and in a national perspective, the decision by the government not to ratify the Kyoto Protocol has not eliminated the commitment toward supporting renewable energy projects in general. This is demonstrated by the Commonwealth Mandatory Renewable Energy (Electricity) Target (MRET) (AGO 2000) legislation;

The MRET is legislation obliging sellers of electricity to submit tradable Renewable Energy Certificates (RECs) each year to demonstrate they have met their share of the laws target. Failure to meet the target triggers a shortfall penalty of A$40 for each green megawatt hour not delivered. The legislation has sparked strong wind power growth (Wind Wire: Doing well 2004, p.20).

Should the MRET commitment be reduced or merely maintained, as has happened to similar legislation in Germany (Knight 2003), the risk remains that wind energy project development in Australia will stall. Recent decisions to retain the existing MRET level for Australia has concerned the wind energy industry and has caused most projects to cease progress. It is now well recognised (Brazzale 2005) that the MRET requirement for Renewable Energy Certificates (RECs) is oversubscribed and the consequent reduction in demand for renewable energy certificates has left many renewable energy projects in an unsaleable situation when it comes to potential financing of projects.

Grid infrastructure

The ability of the electricity grid to accept electricity from wind energy projects has been highlighted as a major issue for future wind energy development in a recent report commissioned by the AGO. This report suggests that the Australian National Electricity Market (NEM) could readily accept 8000MW of installed wind energy under certain conditions (Outhred 2003, p.3).

To achieve this however, Outhred has suggested the development of regional wind development strategies utilising advanced wind forecasting techniques. This may assist in overcoming problems associated with resource distribution, land use issues, turbine technology, network connection requirements, network voltage and flow constraints and other planning issues such as electricity despatch.

The feasibility of wind power production forecasting is pursued by Coppin and Katzfey (2003, p.5), where it is reported that in *the range of timescales from about 30min to 7 days there are techniques which can successfully predict the wind with known uncertainty. Many of these are in successful operation overseas, and indeed necessary for the successful coexistence of the large amounts of wind generation capacity installed in some regions with other power sources.*

Such forecasting techniques have the ability to remove the uncertainty associated with despatch of electricity from wind energy generation projects, described as *unscheduled generation*.

Following this CSIRO Report, the National Electricity Market Management Company Limited (NEMMCO) proposes that *significant intermittent generation (greater than 30MW capacity) be required to submit forecast data to NEMMCO for the period beyond approximately 6 hours ahead of real time* (NEMMCO 2004, p.4).

It is assumed that the cost of such forecasting will be borne by the wind energy developer, operator and/or project manager however, such forecasting techniques may prove to be beneficial to the energy generator in maximising potential power prices. This in turn will depend upon the nature of the power supply agreements and/or power purchase agreement (PPA).

2.3.5.2 State and regional risks

Following consideration of the national risks, in particular those associated with MRET and the National Electricity Market (NEM), it is important to consider the risks associated with state and regional legislation. Most significant in priority are those associated with state greenhouse legislation, planning regulations and environmental reporting. Most Australian states have developed guidelines and regulations governing the development of wind energy projects. These guidelines are documented and available to developers to assist them in the planning and development process.

In NSW, legislation has also been developed to encourage renewable energy projects through the creation of the NSW Greenhouse Benchmarking Scheme (Independent Pricing and Regulatory Tribunal of NSW 2006).

NSW risks

The NSW government intervention that potentially introduces further risk to wind developers includes the Planning NSW Wind Energy EIA Guidelines and the NSW Greenhouse Benchmarking Scheme (IPART 2006). The NSW state government has attempted to encourage the development of the wind energy industry through the establishment of a network of wind monitoring masts and the release of the NSW Wind Energy Handbook (2002), and the NSW Wind Atlas (2003). In addition, Planning NSW released the Wind Energy EIA Guidelines (Department of Urban Affairs and Planning 2002), which identifies the important factors to be considered during the environmental assessment of wind farm projects. Many of these factors will be discussed as local project risks in a later section.

It is worth noting at this point that the Australian Wind Energy Association has published the AusWEA Best Practice Guidelines of Implementation of Wind Energy Projects in Australia (AusWEA 2002) which discusses many of the risks which impact the development of local wind energy projects.

The NSW Greenhouse Benchmarking Scheme has been developed to encourage the abatement of greenhouse gas emissions in NSW. Under the legislation large users and retailers are obliged to reduce their emissions according to a determined benchmark. This legislation allows for the generation of NSW Greenhouse Abatement Certificates (NGACs) which may be purchased by eligible participants in order to achieve the required greenhouse reduction. The NGACs are generated by wind energy projects and will usually in the case of wind energy projects be purchased with the electricity produced. These NGACs provide an incentive for the wind energy industry as it presents a potentially higher price for the power produced and a stronger rate of return. Given that the value of NGACs is significantly lower than that of RECs it is unlikely that NGACs will drive further wind energy development in NSW.

Development application processes

In each state of Australia, the development application process is defined by either a local or state government process, which varies according to the state of location, and the size of the project. In NSW any wind energy project over $30M is subject to the state planning requirement for an Environmental Impact Assessment process. This requires a more onerous and detailed development application process as well as a more timely and costly procedure. In addition, the NSW legislation require such development to be considered of state significance, which has a greater obligation for community consultation and impact assessment.

Development application fees

Each of the states in Australia has a different method and process of development application by proponents. In combination with these differing methods a different cost structure is also attributed to the process. In NSW, the value of the development application fee is proportional to the capital value of the proposed project, however due to the high capital value of large-scale wind energy projects, the development application and assessment fee can be significantly greater than the cost of the studies required to prepare the environmental impact assessment and any planning reports. This represents a significant cost to developers that are using private risk capital to progress large-scale wind energy projects in NSW.

Queensland risks

Queensland presently hosts two wind farms, one comprising two wind turbines on Thursday Island and one wind energy project located at Windy Hill in the Atherton Tablelands of Far North Queensland (Stanwell Corporation 2005a). The Windy Hill project was developed by the Stanwell Corporation and comprises 20 wind turbines with an installed capacity of 12 Megawatts (MW). This project was financed by Stanwell and commissioned in 2000 at a time when renewable energy was being considered by most generators.

No further wind energy projects have since been developed or approved in Queensland since this time, primarily due to the poorer wind resource relative to other states, and the commitment of the Queensland government toward gas projects.

The Queensland utilities however including Stanwell, Energex, Ergon and Tarong have all demonstrated a commitment toward renewable energy projects in the other primarily southern states.

South Australian risks

The major risks to projects in South Australia are the new licensing and grid transmission connection regimes which have been developed by the Essential Services Commission of South Australia (ESCOSA 2005). This Statement of Principles specifies the licensing requirements of wind energy generation facilities in SA. These requirements were developed following a rapid rise in the development of proposed wind energy farms in the state which purportedly will place a risk on grid stability and reliability in SA. The wind energy association disputes the requirements and says it placed an unnecessary and unfair burden on small energy generators.

On some sensitive coastal locations in SA, communities have responded negatively to proposed wind energy projects partly due to a poorly communicated proposal and also due to the high visual impact of such projects by non-participating community members.

The development process for wind farms in South Australia has been documented by Warwryk (undated) and this article remains an important reference for SA developers.

Victorian risks

By far, the greatest risk to developers in Victoria, are the development application requirements for new projects and the risk associated with community acceptance of proposed projects. Victoria has had the greatest backlash against wind energy projects primarily due to the activities of developers, as well as a lack of sensitivity for project visual impacts of locations.

Due to a strong and reliable wind resource, as well as diverse and high energy load centres, developers have focussed some attention on coastal-located projects. These proposed projects have led to a number of controversial confrontations between the local community members and the wind energy industry.

Examples of strong anti-wind community sentiment can be found at the a number of media websites including the ABC and Age (Ketchell 2004; Lennon & Reid 2003).

Recently (AusWind 2006b) it was observed that a proposed wind farm in Southern Victoria was refused permission by the federal government due to the risk of mortality to the threatened orange bellied parrot.

The state of Victoria recently announced that it would adopt an internal state renewable energy target of 10% (Government of Victoria 2006). This has led to the announcement of two new projects which will progress to construction in this state.

Tasmanian risks

Tasmania is a significant producer of renewable energy and Hydro Tasmania is the largest renewable energy generator in Australia. Hydro Tasmania and its new development subsidiary Roaring 40s is the largest wind energy developer in Tasmania. As a consequence the local market is dominated by a private company which has strong links to government and the major utilities, seriously threatening the entry of other development players entering the market.

West Australian risks

Similarly to Tasmania, the WA market has dominated by a single government owned corporation, Verve Energy (2006a), previously Western Power, which has developed most of the wind energy projects in the state. Verve Energy also owns and manages the transmission lines which transport the electricity throughout the state.

Northern Territory risks

The Northern Territory has a limited market due to the restrictive loads in Darwin and some of the remote industrial areas, however is also subject to strong tropical cyclones, which have the potential to damage turbines. There are no major wind energy projects located in the Northern Territory however, there are a range of small-scale local wind energy projects located in remote areas.

This section has sought to describe the risks associated with the development of wind energy projects in each of the Australian States. The next section deals with the more specific project risks associated with local and regional project developments in Australia.

2.3.5.3 Local and individual project risks

This section will seek to describe the local risks associated with wind energy development in Australia and will seek to follow the chronological project development provided by Table 2.3 (below). Many of these development risks are discussed by the Best Practice Guidelines for Wind Energy which were developed by the Australian Wind Energy Association (AusWEA 2002).

Table 2.3 (Repeated) General classification of risks associated with wind energy projects

Risk Factor	Subcategory	Risk Stakeholders
Prospecting	*Land assessment*	*Developer*
Land Security	*Wind Monitoring Agreement*	*Landholders/Developer/Legal advisors*
	Land Lease	*Landholders/Developer/Legal advisors*
Wind Resource	*Monitoring/modelling*	*Developer/Contractors*
Feasibility Studies	*Economic modelling*	*Developer/Contractor*
Development Application	*Environmental Impact Assessment*	*Developer/Contractors*
Licensing/Permitting	*Approvals and Reporting*	*Developer/State agencies/local govt*
Grid Connection	*Study/Agreement*	*Developer/Contractor/Network Service Provider*
Power Purchase	*Power Purchase Agreement*	*Developer/Utility/Legal advisors*
Finance	*Debt*	*Developer/Institution/Legal advisors*
	Equity	*Developer/Shareholder/Institution/Legal advisors*
Construction	*Construction Agreement*	*Developer/EPC/Turbine manufacturerShareholders/Legal advice*
Operation & Maintenance	*O&M Agreement*	*Turbine manufacturers/entity*
Decommissioning	*Decommission Agreement*	*Entity/Subcontractor*

Source: Finlay-Jones (2004)

Prospecting

Prospecting typically describes the scouting of suitable and available land for development. This land usually requires the characteristics of:

- adequate and reliable wind indicators
- elevated and/or exposed
- suitable and nearby grid transmission
- cleared and modified landscape

The greatest risk for developers during the prospecting period is the time taken and resources required to identify suitable and available land areas by the prospector.

Land security

Whilst it may be a time consuming exercise, the objective of the land security is to provide comfort to both the landholder and the developer that the land and resource is suitable for the proposed development. This will likely be achieved by an *option to lease* the land, should the wind prove suitable. The risks associated with this process include the quality of the documentation and the time required to achieve completion.

Wind resource measurement

Wind resource measurement is typically implemented using wind monitoring masts and anemometers measuring wind speeds at a range of heights up to and possibly over the proposed hub height of the wind turbines proposed. The importance of calibrated anemometers, correctly located and installed is emphasised. The duration of measurement is dependent upon the financing requirements and the confidence required by the developer and investor.

Feasibility studies

When sufficient data of a quality is collected it may then be analysed to produce energy estimates, based upon the proposed turbine type and output. Proprietary and in-house software packages (eg *WindFarmer*) help provide developers with an estimate of energy output based upon the estimated wind resource and the proposed turbine locations.

Development application and environmental impact assessment

Assuming that the feasibility study provides sufficient information to progress, the development application process is dictated by the local and state legislation. In NSW, projects over the value of $30M are deemed to be state-significant and fall into a state-based process of approval (Planning NSW 2005). The state significant path may represent a more costly and time consuming path than perhaps the local government path, however this will depend upon the location and the sentiment of the local community to such development.

Environmental risks

According to the state and federal guidelines there are a great variety of environmental risks to be considered in the development of wind farms. The NSW Planning Draft EIA

Guidelines (Department of Urban Affairs and Planning 2002), list the main environmental considerations as:

- Greenhouse and Energy Issues
- Landscape and Visual Issues
- Noise Issues
- Air Quality Issues
- Soils, Drainage and Geological Issues
- Flora and Fauna Issues
- Heritage Issues
- Infrastructure and Utilities Issues
- Social Issues
- Economic Issues
- Cumulative Issues

Licensing and permitting

The licensing and permitting of a wind energy project varies depending upon the state of origin of the proposed facility. The Australian Energy Market Commission (AEMC) is responsible for rule-making and market development of the Australia Energy Industry (AEMC n.d.), whilst the Australian Energy Regulator (AER n.d.) enforces the rules.

Generators are required to abide by the National Electricity Rules which are administrated by the National Electricity Market Management Company (NEMMCO n.d.), which was established in May 1996 to implement, administer and operate the wholesale exchange and to manage the security of the power system. This system of management is to ensure the reliability and stability of the electrical transmission grid system and market.

Grid connection

Grid connection involves the physical connection of the wind farm to an electrical transmission line, which is owned by a network service provider (NSP). As these NSPs are also required to abide by the National Electricity Rules, it is important that they understand the risks associated with the generation of electricity from connected wind farms. As wind farms provide intermittent energy (when the wind is blowing) it is important that the reliability and stability of the grid is maintained, whilst allowing for the energy from the wind farm to be transferred into the electrical system. This requires project proponents to work closely with the NSPs in order to facilitate the appropriate studies and facilities to allow this to occur in a cost effective and timely manner.

Power purchase agreement

The ability to obtain an off-take agreement, or power purchase agreement (PPA) represents one of the greatest risks to wind energy developers in Australia. Typically these PPA agreements define the price of the electricity and the price and volume of the coincident renewable energy certificates (RECs) and the purchase period, which will in turn determine the viability or otherwise of the project. Over the past 18 months the markets ability for wind energy project developers to obtain agreements which will finance the projects, has declined significantly.

Finance

If a suitable power purchase agreement can be completed, the availability and cost of finance will determine whether the project may proceed. Typically finance is divided into debt and equity which is often split in a range from 20:80-25:75. Large developers with sufficient reserves may elect to finance the project from the balance sheet, which is cheaper.

At the present time, the availability of finance for well developed wind farms is high, with many Australian fund managers being forced to seek suitable projects overseas (O'Sullivan 2006).

Construction

Construction risks may arise through such factors as geotechnical risk, contract interfacing issues, grid connection issues, and timing of commissioning (Ward 2004). Many of these risks may be reduced through the development of an Engineering, Procurement and Construction (EPC) agreement with a specialised contractor. An EPC contract normally defines the cost of the construction, the terms and conditions of the acquisition and construction process, and the warranties and obligations placed on both the principal and contractor. Due to the large number of potential risks associated with this phase of development, it is not the intention of this research to investigate the many and diverse construction risks associated with wind energy developments in Australia.

Operations and maintenance

Due to the long potential life of wind turbines (25-30 years), the operations and maintenance risks require careful management by the developer and owner of the wind farm. This risk is often reduced by an Operations and Maintenance (O&M) Agreement with a preferred contractor, either in conjunction with the turbine supplier or under a separate arrangement. Warranty agreements also are normally involved in this component of the development process.

Decommissioning

Decommissioning of wind energy projects also involves a range of inherent risks. These risks are not the subject of this research project. As the global industry is approaching the first phases of decommissioning of older facilities, options exist for retrofitting of old sites with new technology, and for resale perused turbines.

2.3.5.4 Social and cultural risks

Further to the discussion of cultural risk is that attached to the disenfranchisement of local communities due to the development of large scale projects.
Flyvbjerg, Bruzelius and Rothengatter (2003), argue that large (*Mega*) projects have traditionally excluded public involvement in the project development process, and it could be argued that despite a pathway for most project development processes in Australia, that greater public involvement is required. This factor is also highlighted by the recent actions of the Federal Minister for the Environment and Heritage (AGO 2006) through the release of a discussion paper on a National Code for Wind Farms in Australia.

The methodology for achieving cost-effective and satisfactory comprehensive community consultation processes is not clear and until it is so, developers will need to ensure that such risks are identified and managed appropriately.

In terms of cultural heritage impact risk in Australia, the greatest risk to wind developers is that of cultural heritage assessment and monitoring. Whilst most natural heritage issues seem to have a greater propensity to be identified, quantified and monitored, some heritage issues cannot be adequately assessed until actual siting of turbines onto proposed excavation areas. For developers, this presents a significant potential risk whereby operations can be ceased if the site is deemed to be significant at the time of excavation.

This represents risk to developers in terms of lost work hours, inability to plan installation operations adequately and ultimately decreased project viability to greater construction costs, if the project is approved at all. Three wind energy projects in South Australia have been delayed to various extents, as a consequence of local cultural heritage issues.

This concludes the discussion on local risks associated with wind energy projects in Australia. The next section moves into the exploration of the research domain and a definition of the research problem.

2.4 The research domain

2.4.1 The research problem

The research problem identified for this research is the management (identification, assessment and minimisation of exposure) of risks associated with the development of wind energy projects in Australia.

2.4.2 The research questions

The research question is:

> *How can the project management function of the development process of wind energy projects minimise the associated risks?*

Put another way the research seeks to; *identify, assess and minimise the risks associated with the development of wind energy projects in Australia.*

2.4.3 The research objective

So the research output report might be titled:
Strategies for minimising risks associated with the development of wind energy projects.
An opportunity exists to produce a risk register and a handbook of risk management issues for wind development in Australia in combination with a model for risk minimisation.

2.5 Conclusion

The risks associated with the development of wind energy projects in Australia are diverse and varied, possessing influencers at the global, regional and local level, as well as in terms of commercial, environmental and social impacts.

The major risks identified in this literature review for wind developers in Australia include global, national and local risks.

The significant global risks include international agreements, community acceptance and substitute technologies. On a national level, the important risks include supportive legislation, electricity marketing and management systems. On a state basis, government legislation plays a significant role in the potential of project development with respect to greenhouse targets, as well as development permitting.

Locally, wind energy projects are subject to a variety of commercial, environmental and social risks. Significant commercial risks include energy production, sales/offtake risk, and financial risk. Environmental risks include visual amenity, impacts to flora and fauna, and cultural heritage.

The most significant risk to Australian wind energy project development as identified in the literature is the limitation of the national mandatory renewable energy legislation which is now impacting on any further development.

2.6 Discussion

The literature review has sought to examine the three parent disciplines of project management, risk management and wind energy development. The literature review has demonstrated the extent and quality of research literature available to researchers in the area of project management and risk management. Also apparent is the relative lack of literature available on the subject of risk management in wind energy development. Consequently, this research project will seek to determine the major risks associated with wind energy project development, and by utilising the theory and practice from other project management disciplines, such as the construction industry will seek to offer some management options to better manage the key risks in wind energy development.

3 Chapter Three – Methodology

3.1 Introduction

The literature review demonstrated that the body of knowledge for project management and risk management is reasonably well established. However, how this body of knowledge applies to an emerging area such as wind energy development is hitherto relatively unknown. As noted in Chapter 1, the objective of this research project was to identify, assess and manage the risks associated with wind energy development, with particular reference to the Australian context. Secondly, it was to examine how, if at all, the literature about project management and risk management is consistent with this specific instance.

The research methodology involved comparative case studies and considered a range of completed wind energy projects in different states, at different stages of development to determine the main risks and the risk management issues associated with each project.

The output of the research is a register of identified risks and options for a range of strategies to reduce the risk associated with development of wind energy projects in Australia, potentially with application for other types of projects in various parts of the world.

Special consideration for the risks associated with mega-projects as identified by Flyvbjerg, Bruzelius and Rothengatter (2003), suggest strategies to reduce these risks and may assist to develop a more viable and sustainable renewable energy industry.

3.2 Justification of the methodology

The subject of risk management within the wind energy industry within Australia has a relatively small number of projects, and hence a small sample size. The subject area is limited and requires some exploratory work to determine the actual risks involved in wind energy development in Australia. In addition the subject matter is complex and subjective which further requires qualitative methodology.

Given that the matter within the research project is not clearly quantifiable and required some interpretation of subjective issues and data, a combination of *qualitative and quantitative* methodologies was adopted. This combined the collection and use of qualitative and quantitative data during the interview survey process (Bourgeois & Eisenhardt 1988; Yin 1984).

Eisenhardt (1989) describes how the combination of qualitative and quantitative data types can be highly synergistic. This was also described by Mintzberg (1979) and Jick (1979).

3.3 Defining case study research

A case study involves the study of an example – a case - of the phenomenon being researched (Ticehurst & Veal 2000).

In this research, the unit of analysis examined was the industry of wind energy development within Australia. The number of projects examined was determined by the cooperation and participation of the relevant project developers, within the greater population of projects completed in Australia and listed in Table 3.5. Ultimately 8 projects were considered based upon variations in project size, location and developer.

3.4 Justifying case study research

Case studies can be exploratory, descriptive or explanatory (Yin 1994). First, in this research we are seeking to ask the question, “What are the risks associated with wind energy developments in Australia?” This is an exploratory question that may lend itself to other forms of research, except for the fact that the research is also seeking to determine which of the risks are the most critical.

The case study research methodology is usually based on many interviews within 4 to 14 cases conducted using set questions in an interview protocol (Perry, Riege & Brown 1999). For this research, the development organisations involved in 8 successfully completed projects in a variety of states in Australia were interviewed.

Perry, Riege and Brown (1999) describes the four major reasons for using case studies research methodologies in network marketing, which apply equally well for this research. Firstly, and usually early in the research, qualitative methods address theory construction and building, rather than testing and verification. That is to say, case studies can provide the primary theories for particular phenomena, through comparison and examination for similarities and differences between cases. In this research similarities and differences are sought between project risk management techniques and risk perceptions.

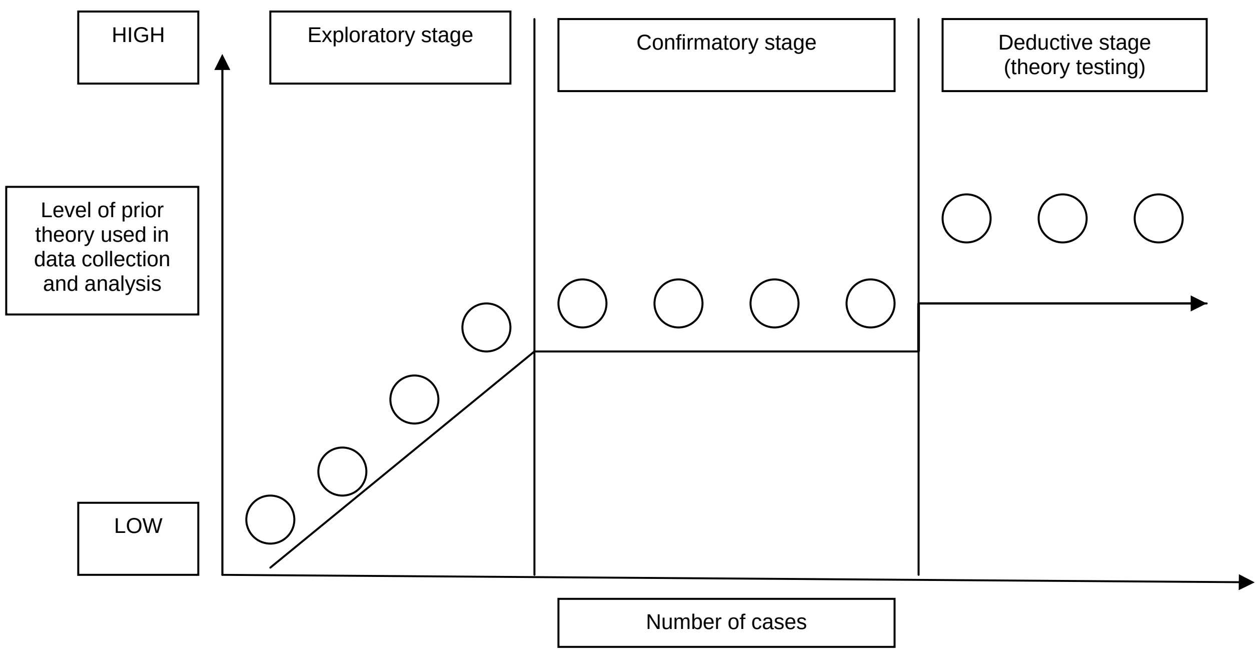
The second reason for case study research is to gain an understanding of the phenomenon. In this research, the issue of risk and risk management is perceived differently by various project organisations. It is therefore important to understand how and why organisations approach project risks differently. Becoming closer to the organisations and the projects provide the research with a greater intimacy of the issues and how they are addressed by management.

The third reason described by Perry, Riege and Brown (1999) for case study research is the classification into categories and the identification of inter-relationships between those categories. This allows the isolation and definition of categories as precisely as possible and then the determination of relationships between them. For this research, the development of a comprehensive risk register will allow the categorisation of the fundamental issues, and then the determination of relationships between the respective risks identified.

The final reason justifying case study research described by Perry, Riege and Brown (1999) relates to the ability for case study research to be exploratory as well as confirmatory or disconfirmatory. In the exploratory or theory building phase, case studies can provide preliminary concepts and theories, whilst in the confirmatory stage, cross-case analysis can provide the comparative data for analysis and evaluation (see figure 3.1 below).

Figure 3.1 A comparison of case study research positions

A purely exploratory, inductive position (left-had side) and a preferred, confirmatory/disconfirmatory position (centre) with the deductive stage (right-hand-side).



Source: Adapted for this research from Perry (1998; 2001) and Carson et al. (2001)

In this research project the exploratory stage identified the majority of the risks associated with wind energy development in Australia ie the exploratory stage examined the *what* question (Yin 1994). The confirmatory stage confirms these risks as *genuine* through case study examination, investigating how and why these risks are managed and assessed. The deductive stage then investigates the major risk management techniques adopted by project management within the wind energy industry.

Case studies of real projects, which have already been brought to fruition, are able to demonstrate the critical risks associated with wind energy development in Australia. It must also be remembered that many prospective wind energy projects may not have been brought to commissioning due to a variety of reasons.

In this research, the *how* and *why* of the risks will be reviewed (Carson et al 2001; Perry 2001; Yin 1994). As these project examples are historical in their nature, the research is cross sectional, however through an interview questionnaire process, the project managers were be able to describe methods to prevent or reduce risk in these and hopefully future projects.

Thus, in summary a case study approach can be used when;
a how or why question is being asked about a contemporary set of events over which the investigator has little or no control (Yin 1994).

3.5 Criteria for judging the quality of case research

Given the justification of case study research for this project, this section discusses the criteria for judging the quality of case study research within the realism paradigm. Each of the criteria are defined and described in relation to the research project.

The six criteria for judging the quality of case study research within the realism paradigm have been identified by Healy and Perry (2000) as:

- ontological appropriateness
- contingent validity
- multiple perceptions
- methodological trustworthiness
- analytic generalisation
- construct validity

The first three criteria relate to the differences between the realism paradigm and those of constructivism and positivism, whilst the last three criteria relate to the nature of case study methodology. Each of these criteria will now be explored in more detail within the context of the research project.

3.5.1 Ontological appropriateness

Ontological appropriateness describes the positioning of realism relative to the paradigms of constructivism and positivism. Whereas constructivism tends to lie within a subjective framework due to the orientation of the researcher and positivism operates in the objective world (Healy & Perry 2000), realism tends toward a world which tends toward a complex cocktail of independent and dynamic ideas and concepts.

Within the framework of this research, investigations involved literature review, case study analyses and questionnaires, which tended to seek to retain some objectiveness whilst seeking to remove subjective factors.

3.5.2 Contingent validity

Contingent validity in case-study research relates closely to internal validity within positivist research. However, where internal validity indicates a causal relationship between dependent and independent variables (Yin 1994), contingent validity emphasises that causal impacts are not fixed but are contingent upon their environment (Healy & Perry 2000).

This research seeks to determine and discriminate between risk management strategies of a variety of projects and organisations in several locations. Therefore, the realism paradigm allows for the consideration that the risk strategies adopted by one particular project may be completely different to those taken by another organisation in a similar circumstance or environment.

3.5.3 Multiple perceptions

Epistemologically, positivism assumes that a single reality exists, which is value free and awaiting discovery. Conversely, constructivism and critical theory assume a close and intimate relationship between the subject matter, and thus a totally subjective perception. Realism on the other hand, relies upon multiple perceptions about a single reality (Healy & Perry 2000). The researcher’s reality is achieved by triangulation of information and data from a variety of sources and seeks to take account of potential biases and interpretations using peer support techniques.

3.5.4 Methodological trustworthiness

Methodological trustworthiness (Healy & Perry 2000), describes the auditability of the data and information in the research, and relates closely to *reliability* within the positivist paradigm and *consistency* or *dependency* within constructivism.

Reliability refers to the ability for a researcher to reproduce the findings of the research using the same methodology and techniques (Yin 1994), whereas *consistency* or *dependability* are terms used to describe the procedures of constructivist research to justify the findings.

In this research project, the data used is directly referenced and provides a strong auditable and logical trail. In addition, the use of peer support mechanisms and a case study database (Yin 1994) ensures a high level of methodological trustworthiness.

3.5.5 Analytic generalisation/theory building

This criteria of case study research quality is described by many terms including *external validity* (Yin 1994), *transferability, theory building* and *analytical generalisability* (Miles & Huberman 1994, p.278).

External validity is *the extent to which causal relationships can be generalised to and across different times, settings, persons and measures* (Lincoln & Guba 1985, p.22). In other words external validity seeks to expand the findings of the research from a sample population to the gross population, or for a particular phenomenon or case.

This research seeks to determine whether projects within the wind industry perceive the development risks to be the same and to the same consequence. If so, then the research may be able to make some generalisations to other types of renewable energy projects, even perhaps to locations outside Australia.

3.5.6 Construct validity

Construct validity refers to the development of a set of operational measures (Yin 1994) which are designed to build the arguments based upon the case studies assessed. For case study research, the three methods normally adopted to achieve construct validity include:

- multiple data sources
- establishment of a chain of evidence
- review of draft case research by key informants (Yin 1994).

This section has examined the criteria used to assess the quality of case study research. The implementation of these criteria ensures that the project has been appropriately developed, audited and scrutinised.

3.6 The framework for the case study research

The use of case study research for this project is justified by the arguments in the previous section, and the elements to ensure the quality of the research discussed. The next section will describe the framework of the procedures for the research.

Table 3.1 The framework for the case study research

Prior Theory
Research Design for case selection
Types of Case Studies
Selection of Cases
Number of Cases and Interviews
Data Collection Procedures
Interviewees Actions during the interview
Case study protocol
Analysing the Data

Source: Developed for this research project

3.6.1 Prior theory

The level and volume of *inductive* theory building, or theory testing (*deduction*) required for case based research is debateable. Carson et al. (2001, p.96) argues that the level of *induction* compared to *deduction* is dependent upon the *availability of relevant prior theory*. Researchers such as Dyer and Wilkins (1991), and Eisenhardt (1989) argue that case research should be purely inductive, relying upon *rich descriptions of the context* within which the research occurs. Alternatively Yin (1989), argues for the establishment of prior theory, using case research for the deductive process to confirm or disconfirm the theory, using a developmental process.

This research used a combination of the inductive and deductive processes and follows the logic of Parkhe (1993), Miles and Huberman (1994) and Nair and Riege (1995). Through this process, prior theory was developed utilising the researcher's prior knowledge within the industry and project management process, casual and informal discussions with other project managers and industry players, as well as literature review. The development of this knowledge bank of prior theory should improve the ultimate quality and value of the research to the industry body of knowledge.

According to Carson et al. (2001, p.99), blending of inductive and deductive techniques can occur in three ways.

1. Early stage convergent interviews during literature review (Nair & Riege 1995)
2. Pilot studies to fine-tune the interview protocol, prior to data collection stage
3. Use of open unstructured questions to commence the interview process.

In this way the questions developed for the interview process are considered in the light of the prior theory collected in the form of literature, pilot studies and additional data.

3.6.2 Implementing the case-based research methodology

This section describes the methodology used in case-based research with particular reference to the justification of the design of this research project.

3.6.2.1 Developing the interview questions

The starting question in an interview should invite the respondent to tell the story of their experiences (Carson et al. 2001; Perry 2001). For example, for this research the leading question was; "*What is the story of your experiences of managing the risks within this wind energy development project?* The nature of the question opens the interview process and reduces the apprehensiveness of the participant.

This commencement process also starts with an inductive approach, leading to an analytical deductive stage. The use of probe questions, usually starting with *How*….? are used and ideally, should not be answerable with a *yes* or *no*.

Probe questions form the major part of the interview process and protocol (Yin 1994) used to provide the framework for the later cross-case analysis of data (Carson et al. 2001; Perry 2001). For example, such probe questions for this research included;

> *What were the main perceived risks associated with this project development?*
> *How were these risks managed?*

The full structured interview sample with questions is provided in the Appendices

In addition, the process included *Likert scaled questions summarising the overall perceptions of an interviewee toward the issue addressed in each question, to be answered by the interviewer* (Yin 1994, p.69) *during or after the interview* (Carson et al. 2001; Perry 2001). Likert scaled questions ask respondents to indicate their level of agreement with a proposition using a standard set of responses (Ticehurst & Veal 2000, p.147). The proposition for inclusion of these Likert scale questions was that the identified risks existed and each of them could be classified on a scale from very low to very high (see table 3.2). These responses were then compared for cross-case analysis. For this research, a list of major development risks were listed, and combined with a 5 category Likert Scale completed by the participant.

Table 3.2 Likert scale questionnaire of potential project development risks

Risk Factor	Subcategory	Risk Classification
Prospecting	*Land assessment*	*Very low, low, moderate, high, very high*
Land Security	*Wind Monitoring Agreement*	*Very low, low, moderate, high, very high*
	Land Lease	*Very low, low, moderate, high, very high*
Wind Resource	*Monitoring/modelling*	*Very low, low, moderate, high, very high*
Feasibility Studies	*Economic modelling*	*Very low, low, moderate, high, very high*
Development Application	*Environmental Impact Assessment*	*Very low, low, moderate, high, very high*
Licensing/Permitting	*Approvals and Licencing*	*Very low, low, moderate, high, very high*
Grid Connection	*Grid Connection Agreement*	*Very low, low, moderate, high, very high*
Power Purchase	*Power Purchase Agreement*	*Very low, low, moderate, high, very high*
Finance	*Debt*	*Very low, low, moderate, high, very high*
	Equity	*Very low, low, moderate, high, very high*
Construction	*Construction Agreement*	*Very low, low, moderate, high, very high*
	Construction operations	*Very low, low, moderate, high, very high*
Operation & Maintenance	*O&M Agreement*	*Very low, low, moderate, high, very high*

Source: Developed for this research

Table 3.3 Likert scale questionnaire of perceived risk management strategies

Risk Factor	Subcategory	Risk Management Strategy
Prospecting	*Land assessment*	*None, informal, formal, highly structured*
Land Security	*Wind Monitoring Agreement*	*None, informal, formal, highly structured*
	Land Lease	*None, informal, formal, highly structured*
Wind Resource	*Monitoring/modelling*	*None, informal, formal, highly structured*
Feasibility Studies	*Economic modelling*	*None, informal, formal, highly structured*
Development Application	*Environmental Impact Assessment*	*None, informal, formal, highly structured*
Licensing/Permitting	*Approvals and Licencing*	*None, informal, formal, highly structured*
Grid Connection	*Grid Connection Agreement*	*None, informal, formal, highly structured*
Power Purchase	*Power Purchase Agreement*	*None, informal, formal, highly structured*
Finance	*Debt*	*None, informal, formal, highly structured*
	Equity	*None, informal, formal, highly structured*
Construction	*Construction Agreement*	*None, informal, formal, highly structured*
	Construction operations	*None, informal, formal, highly structured*
Operation & Maintenance	*O&M Agreement*	*None, informal, formal, highly structured*

Source: Developed for this research

This research used a combination of open interview and Likert-scaled questioning techniques as described. The following section describes the method of case selection for the research.

3.6.2.2 Research design for case selection

This section describes the methodology adopted for the selection of the number and types of case studies for the research.

Types of case studies

According to Yin (1994), there are four types of case study research designs as shown in table 3.4. Type 1 comprises a single case design with a single unit of analysis, whilst Type 2 is a single case design with multiple units of analysis. Type 3 is a multiple case design with a single unit of analysis and Type 4 is a multiple case design with multiple units of analysis.

Table 3.4 Types of case research designs

	Single-case designs	Multiple-case designs
Holistic (single unit of analysis)	Type 1	Type 3
Embedded (multiple units of analysis)	Type 2	Type 4

Source: Adapted from Yin (1994, p.39) for this research

Single case study

The use of only one case study, is justified by Yin (1994), if it meets one of the three criteria listed as:

- the case is critical because it meets all the conditions of a theory
- the case is rare or extreme
- the case provides unusual access for academic research.

Typically if only one case study is used, it is preferred that two or more theories are tested on the case information.

Multiple case studies

More usually, case research is based upon multiple cases in order to achieve *replication* (Carson et al. 2001). Case selection should be made so that they either:

- produce similar results for predictable reasons ie *literal replication*; or
- produce contrary results for predictable reasons ie *theoretical replication* (Yin 1994).

This involves the use of replication logic to select cases, rather than sampling logic. The widest accepted range of cases to use fall between 2 to 4 as the minimum and 10 to 15 as the maximum (Carson et al. 2001, p.104).

This research utilises multiple case studies, limited by the number of private commercial functional projects within Australia, the number of developers associated with the projects and the accessibility to the development managers. This research also utilises the Australian Wind Energy Association (AusWind) as a credible source of relevant data (see table 3.5 below).

Table 3.5 Potential case studies: Projects completed in Australia 2005

Name or Location	State	Owner/Developer	Year	Total Capacity (MW)	No. of Turbines
Mawson Base (2 of 3)	AAT	Australian Antarctic Division	2003	0.6	2
Kooragang Island	NSW	Energy Australia	1997	0.60	1
Crookwell	NSW	Eraring Energy	1998	4.80	8
Blayney	NSW	Eraring Energy	2000	9.90	15
Hampton	NSW	Hampton Wind Park Company	2001	1.32	2
Epenarra	NT	NA	1999	0.08	1
Coconut Island*	QLD	Ergon Energy	1992	-0.01	-1
Thursday Island	QLD	Ergon Energy	1997	0.45	2
Windy Hill	QLD	Stanwell Corporation Ltd	2000	12	20
Coober Pedy	SA	Gov	1991	0.15	1
Starfish Hill	SA	Tarong Energy	2003	34.5	23
Flinders Island 1	TAS	NA	1988	0.06	1
Flinders Island 2	TAS	NA	1996	0.025	1
Huxley Hill King Island	TAS	Hydro Tasmania	1998	0.75	3
Woolnorth Stage 1	TAS	Hydro Tasmania	2002	10.5	6
Huxley Hill Expansion King Island	TAS	Hydro Tasmania	2003	1.70	2
Bluff Point (Woolnorth Stage 2)	TAS	Hydro Tasmania	2004	54	31
Breamlea*	VIC	NA	1987	-0.06	-1
Aurora (Brunswick)	VIC	CitiPower	1993	0.01	1
Codrington	VIC	Pacific Hydro Pty Ltd	2001	18.2	14
Toora	VIC	Stanwell Corporation Ltd	2002	21	12
Challicum Hills	VIC	Pacific Hydro Pty Ltd	2003	52.5	35
Salmon Beach*	WA	Western Power	1988	-0.36	-6
Ten Mile Lagoon, Esperance	WA	Western Power	1992	3.60	8
Armadale	WA	NA	1997	0.03	1
Murdoch	WA	NA	1999	0.02	1
Denham	WA	Western Power	1999	0.69	3
Albany	WA	Western Power	2001	21.6	12
Exmouth Advanced	WA	Western Power	2002	0.06	3
Nine Mile Beach	WA	Western Power	2003	3.6	6
				252.32	207

Source: AusWind (2005)

Selection of cases to be included

The goal of the sampling process is to obtain accurate statistical evidence on the distribution of variables within the population (Eisenhardt 1989). In order to achieve this *literal replication* logic (Perry 2001), projects selected were preferred to be the larger, potentially more commercially viable projects, with representation from all states of Australia, with some selection of polar types to exemplify the extreme examples eg Mawson Base. In this way the careful choice of cases should be made such that they produce similar results for predictable reasons. The case-study analysis hypotheses will however be that for *theoretical replication*. Table 3.6 outlines the preferred projects selected as case studies.

This selection of cases is termed purposeful sampling, in contrast to random sampling (Patton 1990; Perry 2001). Whilst *maximum variation* sampling is preferred for marketing research (Perry 2001) the selection of cases and sampling will allow comparison of similar sized projects in different states, developed by different organisations.

Table 3.6 Case studies selected for this research project

Name or Location	State	Owner/Developer	Year	Total Capacity (MW)	No. of Turbines
Mawson Base (2 of 3)	AAT	Australian Antarctic Division	2003	0.6	2
Blayney	NSW	Eraring Energy	2000	9.90	15
Windy Hill	QLD	Stanwell Corporation Ltd	2000	12	20
Cathedral Rocks	SA	Hydro Tasmania	2005	66	33
Toora	VIC	Stanwell Corporation Ltd	2002	21	12
Albany	WA	Western Power	2001	21.6	12
Hallett	SA	Wind Prospects			
Nine Mile Beach	WA	Western Power	2003	3.6	6

Source: Adapted from the AusWind (2005) database of projects

The 8 case studies selected cover a variety of projects of different scale across most Australian states, with a number of common developers. This number of case studies fits within the preferred number of case studies according to Carson et al. (2001) and Perry (2001) provided that convergence is being achieved.

Number of cases and interviews

Both Carson et al. (2001) and Perry (2001) advocate the use of 30 to 35 interviews in order to provide a *credible picture* of the research world. In this population, the sample size selected provides representation from the major developers who agreed to the research process, across most states of Australia. Only a couple of significant developers declined to the interview process due to confidentiality reasons.

3.6.2.3 Data collection procedures

Following on from the selection of cases and interviews, the methodology for data collection is discussed in this section, and follows the three areas of procedure adopted by Yin (1994) to collect data, namely;

- the researchers actions during the case interviews
- the case research protocol used for interview
- the sources of data collected to supplement the interviews.

Researcher actions during the interview process

The management of the interview process allowed for flexibility on the part of the interviewer in order to extract the information required to form the case study data. The use of an interview protocol ensured that all questions are asked and the *checklist of topics* (Ticehurst & Veal 2000) is completed.

Case research protocol

Whilst flexibility was required for the interviewer during the interview process, the case study protocol contained the data-gathering instruments, the procedures and general rules to be followed (Yin 1989). This section describes the contents of the protocol and demonstrates the links between the interview protocol questions and the research issues.

Content of the case study protocol

In accordance with Yin (1989) the case study protocol required an overview, field procedure, guide and case study questions to be detailed.

The overview of the protocol involved a description of the research project and the background to the study. In this research the background information involved the current status of the wind energy industry, the projects completed and planned for Australia and some of the figures of industry growth expected by industry. The research topic was then introduced to describe the aims, outcomes and potential benefits of the research results to industry and the community. The ethical procedures were then described ie the participant's rights to confidentiality, to terminate the interview and not to be recorded. Upon conclusion, the participants contact details and company position were requested.

The field procedure of the case study protocol involved the collection of data from the open questioning, followed by probing questioning to complete the checklist. Finally the Likert questionnaire completed the main interview process, terminated by an offer to add to or supplement the interview with any further comments or information.

Table 3.7 Content of the case study interview protocol

Protocol Section	**Component**	**Research Project**
Introduction	Introduction of researcher and research organisation and project	Introduction of researcher and research organisation and project
Overview	Background information	Industry status, projects, growth rates
	Project description	Aims, objectives, outcomes, benefits
	Ethical procedures	Confidentiality, interview, recording ethics
	Contact details	Name, position, contacts, role.
Field Procedure	Open questioning	Risks, risk management
	Probing questioning	Types of risks and risk management techniques
	Interview checklist	Risk management Checklist
	Likert questionnaire	Risk management questionnaire
Conclusion	Other issues	Additional data
	Thanks	Thanks and note of appreciation

Source: Adapted for this research project

Data sources to supplement the interviews

General data to supplement the research project was sought from a variety of locations. In this instance the research data was supplemented by data from the wind energy industry found on web-pages, conference proceedings, journal contributions and publications from the industry associations. In addition, relevant information has been sourced from related energy and construction industries with a longer association with risk management methodologies.

With respect to the interview process, closely related project data has been collected from company homepages, company reports, project reports and published papers from several of the participant project managers.

Selecting and contacting the participants

The participants were selected by means of contacts and networks within the wind energy industry. An understanding of each of the selected projects has led to knowledge of the organisations involved in the project development and in most cases the responsible project managers. These project development managers were then contacted by phone, email and personal meetings, in order to request their involvement in the research project.

Data collection

The data was collected using a standardised interview sheet (see Appendices), with the interviewer scribing notes during the process. If a specific answer was required, the interviewer probed with supplementary questioning techniques in order to derive the required data.

Each interview required approximately 1 hour to complete and were mostly conducted by telephone or face to face. A number of respondents preferred to complete the questionnaire by email with follow-up queries and feedback.

3.6.2.4 Analysing the data

It is customary for case analysis to precede cross case analysis (Carson et al. 2001; Miles & Huberman 1994; Patton 1990) *because the case analysis provides the data for the cross-case analysis.* Each case provides a description of approximately half a page per case, with the cross case analysis focussed on the reasons why differences occur with an explanation of why differences were found.

For cross-case analysis data is commonly analysed by content analysis of transcripts, and coding of words and phrases into categories (Carson et al. 2001). These codes then allow the identification, extraction and clustering of words and phrases into concepts and themes (Miles & Huberman 1994). This use of codes is then considered to constitute prior theory, which is used to provide the framework of structure of data analysis reporting.

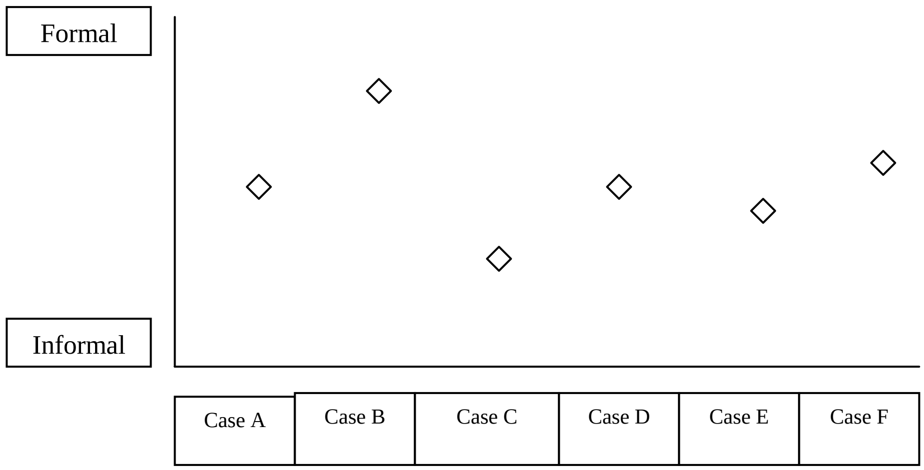
In the cross-case analysis of the projects selected in this research, the differences in the perceived risk types are compared against the existence or type of risk management strategy for that perceived risk.

Comparison with prior theory

Prior theory was used to develop the codes and structure for analysis of the cases and their subsequent comparison. In this research project the understanding of the development process and risk identification process was gained through the literature review process. This prior theory development thus allows for comparison between expected results from literature review and the results from the cross-case analysis.

For example the analysis may seek to compare the pattern of cases for projects against risk management criteria as depicted in the hypothetical Figure 3.2 below.

Figure 3.2 The analysis of cases comparing attitude to management of development risk



Source: Adapted from Carson et al. (2001) for this research

The case study database

The case study database refers to all data that provides supplementary information to the case research that assists to make the data analysis more credible (Perry 2001). This database lists all information such as magazine articles, company brochures, project information that may assist in the triangulation process. Triangulation, or the viewing of the information from a variety of directions is one of the techniques that allows a testing of the quality of the data and its analysis. These criteria for justifying the use of case studies were discussed earlier in this chapter.

3.7 Ethical considerations

There are a number of ethical considerations in the implementation of this case-based research project. This section of the methodology outlines a number of the key ethical issues associated with this research project, namely harm, free choice, privacy, informed consent and research ethics. For this research project, the research was undertaken under guidance of the SCU's Human Research Ethics Committee checklist and application guidelines.

3.7.1 Harm

As the researcher is a project manager within the industry under study, some of the risk management strategies adopted by the case study projects and organisations could be considered the *intellectual property* of that particular organisation. Therefore the information being imparted for the project must be secure or otherwise be withheld from the data. It is imperative to the success of the research project, therefore, that the participants understand the level of confidentiality being afforded to them through this process. In this instance harm relates more to confidentiality of data and results and privacy rather than physical or other distress (Ticehurst & Veal 2000). Consequently all interviews and data collected remain confidential and identities of respondents remain anonymous.

3.7.2 Free choice

Free choice, refers to the ability or want of the participant to be involved in the project (Ticehurst & Veal 2000). Participants in this particular research project were invited to be involved in the research process through the researcher, who in many cases is known to the participants as an active industry participant. Organisations preferring for their results or involvement to be excluded were granted this request.

3.7.3 Rights and obligations of parties involved

The parties involved in this research have obligations affected by ethical concerns. Each participant is obliged to be truthful and provide honest cooperation (Zikmund 2000). The researcher is expected to truthfully represent the purpose of the research, to be objective and to protect the rights of the participant. The sponsoring client of the research, is expected to honour business ethics and have an open relationship with suppliers of research (Cavaye et al. 2003). For this research, there is no sponsoring client, however it must be remembered that the researcher is employed in some cases, by competitive development organisations.

3.7.4 Privacy

The privacy of all participants is to be respected in the implementation and reporting of this research. No details of individuals involved in the research are published except by permission.

3.7.5 Informed consent

Where there is a risk of harm to the participant, it is necessary for the subject to be fully aware of the risks involved, in order to give their informed consent to participate in the project (Ticehurst & Veal 2000, p.53). Therefore, each participant was provided with a letter of introduction explaining the purpose of the research prior to each interview. The letter described the aims and objectives of the research with contact details for further information if required. During the introduction to the interview, participants were informed as to why they were chosen for the research and reminded of the purpose of the research.

This concludes the section on the ethical implications of the case study methodology. The next section describes the traditional prejudices or limitations against case study methodology. The limitations associated with case study research are few, provided that the research process and methodology has been well planned and implemented, the appropriate cases selected and the report well structured.

3.8 Conclusion

This chapter provided the details and justification of the methodology associated with case study and the cross case analysis research. The chapter describes how the case study research was conducted in order to achieve reliability and validity and provide suitable and appropriate justification for the process. The framework for the case study research was summarised, outlining the development of prior theory, case selection and data gathering. Further the method of analysis was described and the limitations associated with this type of research discussed, with these limitations addressed in the context of this research project. The next chapter analyses the data obtained through the case study research process.

4 Chapter Four - Analysis of Data

The previous Chapter described a justification for the methodology for the research project as a Case Study process. This Chapter describes the individual cases selected and the analysis of the data collected for a cross case analysis.

4.1 Introduction

The methodology chapter of the research project described a justification for realism as the preferred paradigm for case study research (Perry 1998). The case studies were selected to provide a combination of both inductive (exploratory) (Yin 1993) and deductive (confirmatory) processes (Miles & Huberman 1994). The types of case studies selected were based upon their geographic location within Australia, the type of developer, as well as their status of development beyond construction. Exceptions to these criteria included the Hallett Wind Farm, which has only recently commenced construction. The number of case studies for inclusion in the research project is limited by the number of completed projects within Australia, the ability to interview the relevant project managers, and the availability of information on the selected projects.

The following analysis of data reflects the types of projects involved in the interview/survey process, the nature of the interview questions, and the responses from the relevant project managers. The analysis provides a brief description of the projects selected, case analysis of each project and a cross-case analysis exploring the common and contrasting themes.

4.2 Methodology

The methodology adopted for this research is similar to that adopted by the International Energy Agency (IEA 2005) study of *Offshore Wind Experiences*, in that it comprises input from project developers collected from a structured interview process.

The data was collected from a structured interview process utilising a standardised questioning procedure. The standardised structured questioning procedure combined both open and Likert scaled questions.

Project managers from 8 projects were selected and interviewed, each providing responses on the individual projects under discussion, as well as views and perceptions regarding the future.

The data was summarised and collated with other information from company reports to provide a case summary for each project. The responses from the participants were then grouped by subject matter to provide a summary for cross case analysis.

The responses from Likert-Scaled questions were not analysed quantitatively, but were inspected and utilised to provide a method of verification of the qualitative information provided, based upon frequency and rating of the response.

4.3 Brief description of cases

The following section provides a brief description of each of the projects selected for case study analysis and a highlight of the risks identified by the data collection process.

Case study one: Windy Hill Wind Farm

Windy Hill wind farm is located on the Atherton Tablelands in North Queensland close to the township of Ravenshoe. The project comprises 20 x 600 kilowatt (kW) Enercon turbines with an installed total capacity of 12 megawatts (MW) (Stanwell Corporation 2005a). The project was commissioned in 2000 and is owned by Stanwell Corporation, a Queensland based utility.

This project was developed to support the supply of *Green Power* for Stanwell, an electricity retailer which has obligations to provide certain customers with renewable derived electricity. At the time of development, the Federal Mandatory Renewable Target did not exist, and this represented a significant risk to the developer. This risk was managed by sharing the risk related to sales-offtake across three electricity retailers.

The major risks identified by the developer of the project which rated as *very high*, were the land security (land lease) issue and the power purchase agreement. As the project was financed on balance sheet, risks of capital and project finance were reduced significantly.

To further reduce risk associated with energy output estimates, the developer allowed a 10% energy production discount contingency factor. In order to reduce the operations and maintenance risk, the manufacturers of the turbines were contracted for five years, and this cost was built into the operational cost model.

Most of the risk management strategies adopted in this development project involved formal or highly structured processes designed to reduce development risk factors.

Case study two: Toora Wind Farm

Toora Wind Farm, owned by the Stanwell Corporation was commissioned in 2002 and comprises 12 x 1.75MW Vestas turbines with a total installed capacity of 21 MW. It is located near the township of Toora in the South Gippsland area of Victoria (Stanwell Corporation 2005b).

The project was initially proposed by the Sustainable Energy Commission of Victoria in the 1980s, which provided for an extended period of 15 years of monitoring and associated data from the owner company TXU. In the wake of the Toora project being revived by the Stanwell Corporation in 1999 (Collins 2002), community concerns were heightened as an increasing number of developers descended on the area.

Land security for long term leases and power purchase agreements were identified as the major risks for this project, with community opposition identified as a major risk to project approval. The council approval for the proposed project was challenged by individuals who felt disenfranchised, who linked with other community groups to oppose further wind energy development in the local government area. This resulted in an appeal to the Victorian Civil and Administrative Tribunal (VCAT). An eight month appeal process resulted in a nine month delay to the project development and added considerably to the project cost in terms of delayed revenue, exchange rate shifts which affect the price of imported equipment and legal costs.

A further risk associated with the project was the duration of the Power Purchase Agreement (PPA) at 5 years which assumed that demand for renewable energy would drive electricity prices up. This has not yet occurred in the marketplace, and with the current position of the Federal Government, is unlikely to change.

Case study three: Blayney Wind Farm

Blayney wind farm is located on two farming properties near the township of Blayney in central NSW. It is owned by Eraring Energy and comprises 15, 660kW Vestas turbines totalling an installed capacity of 9.9MW. Developed by Pacific Power International, it was commissioned in October 2000 at a total capital cost of $18 million (EcoGeneration 2000).

The critical risks in the development of the project were identified as data risks, modelling uncertainty, financial risk and construction risk. The data risks were reduced by maximising the collection period for data collected, and cross correlating the data with other local data sources. Modelling uncertainty was addressed utilising both internal and external models, allowing for verification of results. Many scenarios and sensitivity analyses were conducted to allow for errors, bias sources and the data and model assumptions for losses. A major financial risk identified related to fluctuations in the exchange rate for the high capital value imported wind turbines and components. During construction of the project, the main risks were associated with poor weather and the subsequent management of subcontractors.

Reflecting these critical risks, data monitoring and modelling was identified as the most important risk in this project, followed by the power purchase agreement (PPA) and the risk associated with construction operations.

The PPA was assigned a high risk classification due to the hard negotiations which occurred for a long term (project life) contract. In order to reduce these risks, Pacific Power International (PPI), adopted a number of strategies which suited the project management function and the organisational capabilities.

The adoption of internalising the monitoring and modelling function has led to an increased intellectual capacity and knowledge building within the organisation. This has reduced the reliance on external contractors and consultants in the analysis and modelling stage of development.

The difficulties associated with the negotiation of the long term PPA, have been offset by allowing for a realistic guaranteed power price for the life of the project, in turn allowing for the internal (balance sheet) funding of the project. During the construction phase of the project, risks were assumed by the development organisation, by project managing the construction and supervising the various contractors and site logistics. This allowed for reduced and internally controlled total construction costs.

Future risks associated with the Blayney Wind Farm have been identified as environmental compliance, machinery maintenance and decommissioning. Monitoring of performance associated with noise and fauna impact may need to occur. The risk of parts and component damage or failure is offset by the ability to rapidly repair any faults.

Case study four: Albany Wind Farm

Albany wind farm, located 12km south-west of the city centre, was ten years in the planning, and is situated in an elevated position 80m above sea level (Western Power 2002a). Officially opened in 2001, the project consists of 12 x 1.8MW Enercon E66 turbines, which have a 65m tower and 35m blades. The project was developed and managed by Western Power, now known as Verve Energy (2006b), the major energy asset management utilities in WA.

The major risks associated with this project included community acceptance, transmission access, energy yield modelling, environmental care and construction risk.
The community acceptance risk was managed through a thorough consultation and educational campaign utilising local media and community groups. The connection risk was associated with a lack of experience in the technology and exacerbated by the need for transmission access and *ride-through fault* capability. At this time, no turbines were available to achieve this, despite the completion of the supply contracts for the turbines.

Energy yield estimates were dependent upon existing models and assumptions. The project layout and turbine locations were thus dependent upon the capabilities and restrictions associated with the existing models. Flora disturbance risk was significant and had the potential to stop development. This risk was managed by ensuring that all tracks were rehabilitated to create a new increase in native flora coverage on-site.

Construction risk was considered high due to high wind speeds at particular times of year. In order to reduce this risk, contracts were completed to ensure that turbine supply and erection occurred within a narrow, low wind speed period. Western Power was able to assume some of the risk of this process and managed the process to ensure that risk was minimised whilst construction speed was maximised.

Through the interview process, the highest perceived risks ranked for this project development was that for the development application and environmental impact assessment process. The additional risks associated with the project included those associated with local manufacturing content, vandalism, politics and media.

The requirement for local manufacturing content resulted in local manufacture of towers, transformers and cabling. This placed pressure on the supply contract due to the need for transfer of intellectual property, as well as the risk of increased prices for local components. The risk of vandalism was primarily due to the site being a major thoroughfare for hiking with unrestricted access to the public traversing the site. Property was known to have been stolen and some vandalism has occurred.

Due to the nature of local media as an important stakeholder, with sufficient power to potentially jeopardise local projects, the project management embarked on a major media campaign to educate and inform the local community about the benefits of wind energy. A full-time media contact was engaged, who also provided media training to personnel and also implemented a comprehensive stakeholder management plan.

Case study five: Nine Mile Beach Wind Farm, Esperance

Nine Mile Beach Wind Farm was developed, and is now owned by Verve Energy (2006a), previously Western Power, for a cost of $10.6 million. It is located near Esperance in WA and was completed in 2003. The project comprises 6 x 600kW Enercon E40 turbines connected to Western Power's electricity network at Esperance (Western Power 2002b). The turbines are mounted on a 47m tower and carry three 22m blades.

The Nine Mile Beach project involved selling energy into an electricity grid dominated by a single gas turbine-based generator. This generator agreed to purchase the energy from the wind farm, however the negotiation of the off-take agreement proved to be one of the major risks for the development of this project.

The technical risk associated with the high penetration of wind energy into a gas turbine based system was high, given that such an arrangement had not been previously attempted. The technical solution was integral to the off-take agreement, as it established the requirements for how a wind farm would operate in conjunction with a gas turbine generation. These technical requirements resulted in a reduced potential energy output from the wind farm, as output is regulated dependent upon the load base in Esperance and the amount of gas generation.

Esperance now has 25% of its energy contribution from wind, thanks to the establishment of a workable power purchase agreement, resulting in the construction and operation of a viable and sustainable wind project which meets all original business case indicators.

The highest categorised risks identified, were those associated with wind resource modelling, power purchase agreement and the construction operations. Other risks not previously identified included political risk, equipment maintenance and safety.

Since Verve Energy is a State Owned Corporation, political risk is inherent in any long term project. Changes in policies have the potential to place risk on such projects, particularly high value projects which tend to attract public and political attention.

Safety risk during construction was identified as a high risk issue for this project. The main safety issues related to safety responsibility, relevant legislation, safety risk assessment, hazard reduction and operationally relevant safety management plans. Safety risk is mitigated through construction management planning strategies which stipulate tactics such as tool-box meetings, environmental induction training, contractual penalties for breaches, and job safety analyses.

Approaches adopted by Western Power to reduce development risk include formal and highly structures approaches to technical, environmental, financial and energy modelling as well as a formal post project review process which audits the performance of the project alongside company benchmarks.

Technical risk is managed by the engagement of competent staff members who have an appreciation and understanding of the issues. Verve Energy prefers to develop this resource internally to develop intellectual property and reduce the risk associated with future project development.

Financial risk is lowered by utilising experienced staff members. For example, capital costs estimates are carried out by experienced estimators with relevant country experience. Such costing estimates usually fall within 1% of expectation. Contingency budgets are allocated to projects and situations where change or modification must be catered for.

Energy yield assessments are usually undertaken in house and typically use standard software calculations which assume certain criteria. These criteria may vary depending upon wind speed, topography, hub height and a number of other factors. Verve Energy expects energy yield analysis to be between 1-3% of actual, which in-practice requires sophisticated non-linear modelling and cross-referencing of collected data.

Case study six: Mawson Wind Farm, Antarctica

Mawson Wind Farm is owned and was developed by the Australian Antarctic Division, Department of Environment and Heritage. Commissioned in March 2003, the project comprises two 300kW turbines costing AUD$6M in capital value. The objective of the project was to supply energy to the Mawson station and reduce the reliance and risk associated with the 2.1 megalitre annual use of diesel fuel (EcoGeneration 2003).

This project is of great interest to the research project due to the extremes of climate associated with the Antarctic continent and the difficult and remote access issues associated with the Mawson Station. Since the project was designed to supply energy directly to the local station, many of the risks associated with commercial scale wind energy projects do not apply.

The major risks associated with the development of the Mawson Wind Farm were associated with the delivery of the machinery components and the construction process.

The Mawson Wind Farm is a very high risk development requiring the delivery of installation equipment by ice-breaker within a 6 week seasonal window. This construction window comprises the 3 summer months when wind speeds are reduced and temperatures maximised.

During the first delivery attempt, the delivery vessel was delayed for 6 weeks as it became stuck in pack-ice. This led to a delay of 12 months in an attempt to deliver the parts during the following season. Whilst this occurred the nature of the climate only allowed for 2 of the 3 foundations to be prepared due to the temperature requirements of the concrete.

A heavy lift crane was purchased in order to complete the erection of the turbines, however the 100 tonne crane represented the full weight capacity limit of the pontoon barges. As a result, the crane was inched the 100m from the ship over rocks and ice, very gradually. The turbine components were also transported a similar distance using a special purpose-built 40’ trailer.

The turbine tower sections, being oversized, required further special attention in the form of special skids welded to the underside of the platform allowing the large tower sections to be dragged to site.

The turbines, supplied by Enercon, a German turbine manufacturing company, were modified from their standard turbine design to suit the harsh Antarctic environment. This was done by using low temperature steel, shorter towers, re-engineered hold-down bolts and an insulated nacelle.

The major feasibility risks associated with development of this project included the risk of bird strike, high wind speeds and turbulence, as well as the constantly low temperatures. Operationally, most of these risks did not eventuate. Bird kills were very low, and the low temperatures did not produce any icing due to the extremely dry atmosphere in combination with cold temperatures.

The greatest ongoing risks associated with the Mawson wind farm as identified by the project manager have been those associated with operations and maintenance. In particular, the need for continuity of skilled trained personnel to operate and maintain the machinery and control systems. Due to the non-permanent and fluctuating nature of the staff engaged at Mawson, the ability to monitor and ensure the reliable operation of the turbines is a high risk.

Case study seven: Cathedral Rocks Wind Farm, SA

The Cathedral Rocks Wind Farm is located near the southern tip of the Eyre Peninsula in South Australia, about 30km south west of Port Lincoln. The site covers an area of approximately 29 km^2 of private farming land. It consists of 33 2MW Vestas wind turbines totalling a combined installed capacity of 66MW. The blade diameters are 80m and are erected on 60m tall towers. The total capital cost is in excess of $100 million (HydroTas 2005.). The first wind turbine began generating power on April 29, 2005.

The Cathedral Rocks wind farm is a joint venture project between Hydro Tasmania and Spanish renewable energy company EHN and financed by the National Australia Bank (2004). The joint venture company representing Hydro Tasmania's interest is now called Roaring 40s. The joint venture company operates as a special purpose vehicle.

A number of risks have been identified in the development of this project. The approval process required extensive environmental and cultural studies. Fauna studies indicated potential impact on the habitat of the Southern Emu Wren (*Stipiturus malachurus)*, which required minimisation of impact on potential habitat areas during construction (HydroTas n.d.). A heritage agreement was finalised to protect and conserve over 2300ha of on-site vegetation to minimise impact on the coastal vegetation. In addition, the construction of a 30km transmission line was required to connect the windfarm to the main grid.

In the Cathedral Rocks Wind Farm the greatest projects risks identified were those associated with the development application process and the environmental impact assessment and mitigation required.

Case study eight: Hallett Wind Farm

Hallett Wind Farm is a Mid North South Australian development of the UK based developer, Wind Prospect, originally consisting of a proposed 160 turbines, of which 130 have been provided with provisional development consent (Wind Prospect 2005). AGL announced in Jan 2006 (Wind Prospect 2006) that it would construct the 95MW Brown Hill Wind Farm comprising turbines supplied by Suzlon Energy Australia. Construction is expected to commence in September 2006 with commissioning by December 2007.

The primary risks associated with this development were identified as market mechanisms, grid capacity and planning constraints. This was verified by the ranking of the development application and licencing/permitting process as high. Those risks not mentioned in the process included public opinion, competition and market restrictions.

Wind Prospect adopts a formal and highly structured approach to management of development risks according to the interview and survey data. It views the market mechanisms and the match between grid capacity and wind resource as the major risks to continued industry development in Australia.

4.4 A comparison of case responses

In order to compare the cases, this research project has adopted the methodology proposed by Eisenhardt (1989) where cross case patterns are sought through within group similarities coupled with intergroup differences. Also the research utilises the methodology of Perry (1998) where, for each interview question, the cases are placed along the horizontal axis and the Likert scaled summary position of each is placed on the vertical axis. In addition, open questions not containing Likert scaling were analysed using a compare and contrast approach to the responses provided. The following section summarises the responses from the participants in identifying the primary risks to wind energy development in Australia.

4.4.1 The primary risks identified

As an introductory question for the research, each participant was required to consider the main risks associated with the project development. Each risk identified and highlighted in the data collection has been broadly classified and categorised by a code (see Table 4.1 below).

Table 4.1 The main project risks identified by the respondents

Case Number	***Main Risks Identified***	***Code***
1	*Market mechanisms (MRET)* *Grid capacity (esp SA)* *Planning legislation*	*MRET* *Grid* *Planning*
2	*Market mechanisms (lack of MRET)*	*MRET*
3	*Energy output estimates* *Community concerns*	*Energy* *Comm*
4	*Energy output estimates (modelling uncertainty)* *Market mechanisms (no MRET)* *Ongoing PPA*	*Energy* *MRET* *PPA*
5	*Community concerns* *Network connection* *Construction risk*	*Comm* *Grid* *Const*
6	*Sales-offtake agreement (PPA)* *Network connection issues*	*PPA* *Grid*
7	*Construction risk* *Operations & Maintenance risk*	*Const* *O&M*
8	*Development approval process* *Political and regulatory framework* *Community concerns* *Turbine supply risks*	*Planning* *MRET* *Comm* *Turb*

Source: Developed for this research

These risks, having been categorised are then counted to determine the frequency of responses (see Table 4.2 below).

Table 4.2 Frequency of main risk responses

Code	*MRET*	*Comm*	*Grid*	*Planning*	*Energy*	*PPA*	*Constr*	*O&M*	*Turb*
Frequency	*4*	*3*	*3*	*2*	*2*	*2*	*2*	*1*	*1*

Source: Developed for this research

This frequency of response table provides an indication of the commonality (or replication) of the risk across the sample of projects selected. When prioritised according to the frequency of response, the most important risks were identified as, the MRET limitations, followed by community concerns and grid/network constraints and then planning, energy, PPA and construction risk.

4.4.2 The primary risks prioritised

The Mandatory Renewable Energy Target (MRET) and the Renewable Energy (Electricity) Act 2000

The ***Renewable Energy (Electricity) Act 2000 and consequent*** MRET (AGO 2000) legislation was identified as the main priority risk for the projects surveyed. The risk associated with this legislation was dependent upon the stage of development of the project. Projects which were commenced before the release of the legislation highlighted the need for such legislation to support the project, whereas projects commenced after the release of the legislation were more concerned for the duration of the Act and the ability for it to change over time.

This Act stipulates the percentage of renewable energy required to be purchased by the electricity retailers, capped at 9,500GW, as well as the sunset of the Act at 2020. This means that at the time of writing, developers have less than 14 years to pay for the finance and capital requirements of the development, a timeframe which is unrealistic for most projects developers and financial institutions. In addition, the original penalty price for not achieving the target of $40/MWh is now reduced to below $27/MWh, a price which prevents developers from receiving a viable price for the energy produced from wind energy projects, relative to the price of coal fired electricity.

Community concerns

The issue of community concern ranks highly within this list of prioritised risks. Wind energy projects tend to attract a good deal of attention from certain stakeholder quarters, with a wide variety of myths and untruths spread about the nature of wind farms. Of great interest are the community concerns associated with noise, visual amenity and landscape change, particularly evident in Victoria where wind farms have been proposed in visually sensitive areas such as the Great Ocean Road. Community concerns also extend to impacts on cultural and archaeological heritage as well as on flora and fauna.

At the time of writing, there is great consternation over federal government decisions to prevent two significant wind energy developments in Victoria and Western Australia on the grounds of potential impacts to birds (AusWind 2006b). Community concerns also tend to be compounded in areas of high wind resource, as many developers may converge on a locale, seeking to progress projects and tend to create a competitive and potentially conflicting environment for security of project land tenure.

Grid connection issues

Grid connection issues were identified as a major risk by several projects. These risks include the reliability of grid connection studies, the grid connection process, grid connection agreements and grid connection technologies. In SA, strict grid connection rules apply in terms of the obligations and costs applied to new generation. In more remote areas of Australia, a lack of adequate transmission capacity may prevent projects from being connected. Furthermore, the distance from suitable grid connection may be too cost prohibitive to allow the project to develop further. Constrained grids prevent the release of the entire capacity of the energy from the wind farm, reducing the economic viability. The larger the project, the greater the grid connection risk, as the costs of line augmentation and stability regulation (fault ride-through) increase. As more generators place greater pressure on the existing transmission lines, the need for greater regulation and more rules has been identified as a potential risk.

Planning issues

Strongly linked to the previous two risks identified ie community concerns and grid connection, are the risks associated with the planning and approvals process. Local planning regulations and fees vary greatly between local government areas and states. Further, the ability for the federal government to veto projects which have local and state approval has confused and frightened many developers. Without a consistent and level approach to these developments, developers are required to build in a cost factor to cope with such risk. Some projects have been approved locally with such a high number of conditions applied as to render the proposed project economically unviable.

All project development is required to include extensive community consultation as well as environmental impact assessment, which can prove to be expensive and time consuming. Local stakeholders are permitted to appeal decisions made by consent authorities, which may also stall and halt potential project developments. Ongoing environmental monitoring and compliance, regulated by the development approval process was also identified as a significant risk for developers.

Energy generation issues

Energy generation risk is a product of the risk associated with the wind energy resource and the technology utilised to harness and deliver the electricity to the grid. The wind energy resource is typically measured using on-site anemometry and over-time verified against long term wind data. Data measurement typically requires 12 months of on-site local wind monitoring, which is then used to model the wind resource. Modelling of this resource then allows some estimation and calculation of the preferred wind turbine type, locations and size. This modelling then determines the potential output of the farm based upon the availability and suitability of the secure land area.

A number of proprietary software packages have been developed for this purpose, all of which make some assumptions about the wind flow, turbulence, shear etc.

Whilst a great deal of industry confidence exists in this process, it is this estimation of the wind resource, its uncertainty factors and subsequent energy calculation which has an inherent level of risk to developers. Energy generation risk is closely linked to grid connection risk where technologies, distances to grid or existing grid capacities are limiting.

Sales-offtake/power purchase issues

The sales-offtake development risk is usually associated with the process of negotiation of, and completion of a power purchase agreement (PPA). The PPA is critical in the financing of the project in that it dictates the energy price to be paid by the purchaser, the minimum electricity output of the project, the duration of the purchase agreement and usually the method of indexation of the energy price.

The price of the power to be purchased, in combination with the volume of electricity to be purchased will determine the economic viability of the project and hence the ability of the project to be financed.

Prior to the MRET legislation being introduced, project developers speculated on the potential price of renewable energy, based on the demand for Green Energy, and entered into agreements with utilities to ensure that the energy price would cover the costs of capital and finance. Some developers used innovative measures such as splitting the off-take between different utilities to increase the potential returns to the project. Other measures utilised to reduce the off-take risk include maximising the term of the PPA up to 20 years, however this benefit is offset by the potential to increase gains in an increasing market.

To further reduce PPA risk, project developers that are not directly associated with a utility such as a state owned corporation, develop alignments and alliances with potential PPA parties early in the development process. These PPA parties may also include large electricity users such as mines and load centres.

The MRET legislation presently drives the renewable component of the power price within the PPA, as the price of black energy (the price of power from coal-fired power) is well established. At the time of writing, the price of Renewable Energy Certificates (RECs) was below $26/MWh, which is well below the original pre-set penalty price of $40/MWh. For the penalty price to be driven back up, the market competition for RECs needs to be enhanced, and the only likely mechanism for that to occur would be through Federal or State legislative change.

Construction issues

The risks associated with construction were acknowledged by two of the sample projects selected as major risks. The risks inherent within the construction process include poor weather leading to delays and timing issues, management of the interfaces between various contractors and operations, cranage and haulage of large machinery and turbine components, occupational health and safety issues, availability of labour and resources.

These types of construction risks are mitigated through the use of contractual agreements with specialised service providers. Indeed a common model for construction in Australia, is the use of an engineering, procurement and construction (EPC) contract, allowing for a single point of contact with the contractor and a known cost for turnkey construction of the entire wind farm.

This model is losing favour in overseas markets as the cost of the EPC contractor is now becoming prohibitive for the developer and is impacting on developer profits.

Operations and maintenance risks

Operations and maintenance risks normally include such items as the availability of skilled labour and parts, the completion or otherwise of a warranty, operations and maintenance (WOM) contract and the ability for manufacturers to provide adequate warranty of parts following commissioning of the facility.

The turbine manufacturer may elect to offer a WOM as part of a turbine procurement agreement, which will normally cover replacement of faulty turbine components under normal wear and tear for a given time period. The developer will however be required to pay a premium for such a maintenance service depending upon the nature and duration of the warranty period. Many wind farm owners now adopt a position whereby they train internal resources to operate and maintain the turbines following any WOM period.

This section described the major risks as identified by each of the sample projects and prioritised by frequency of occurrence. The next section will outline the ranking of the common development risks in the opinion of the project developers.

4.5 Prioritising the project development risks

The interview process required that the respondents classify the risks listed according to the perceived risk attached to that particular development issue. The classification system allowed for a 1-5 ranking where 1 represented low risk and 5 high risk. The results are shown in Table 4.3 below.

Table 4.3 The ranking of a range of project development risks proposed by the research

Risk Element	**Ranking**
PPA	4.0
Construction operations	3.9
EIA	3.4
Grid connection agreement	3.3
Construction agreement	3.1
Monitoring/modelling	3.0
Approvals and licensing	3.0
Economic modelling	2.8
O&M	2.8
land lease option	2.6
O&M Agreement	2.3
Land assessment	2.1
Land lease	1.9
Debt/Equity	1.5

Source: Developed for this research

Each of these risks factors are described in more detail below.

Power purchase agreement

The power purchase agreement (PPA) was considered one of the most significant risks by the project developers involved in the research. This result supports the data obtained through the interview questioning and the literature review. The present risk associated with obtaining a sales-offtake agreement for a wind project in Australia is that of insufficient pricing of the energy to allow a profitable and sustainable project.

Construction operations

Construction operations ranked as a high risk across most projects. In fact it could be argued that construction operation risk, ranked more highly than that for the Power Purchase Agreement risk. It needs to be noted that most of the projects had already obtained power purchase agreements prior to the MRET being installed, so the priority of the risks may have changed since project inception. Construction operation risks include risks to capital, equipment and schedules. Occupational health and safety risks are high with the movement and installation of large-scale heavy equipment.

The weather also plays a strong role in the ability of wind turbine construction to progress to timeframe. These risks all provide the increased level of uncertainty expressed by the respondents.

Environmental impact assessment

Two of the eight projects ranked the environmental impact assessment as a high priority project risk. Environmental Impact Assessment (EIA) is one method used by permitting authorities to determine whether the impacts on the environment are justified by the approval of the process. The EIA process involves a range of studies including impacts upon flora and fauna, cultural heritage, visual amenity, noise and electromagnetic interference. These studies usually require engagement of local subject specialists and can be a time consuming and expensive process for the developer. The outcome of the EIA will usually indicate the level of probability of successful approval of the wind farm project proposal. However, this is not always the case. Recent veto decisions by the Federal Government, to particular wind farm projects approved by the state, has significantly reduced the level of certainty and the confidence of project developers and investors (Khadem, Minchin & Ker 2006).

Typically, smaller wind energy projects may perceive the EIA process as a lesser risk, since the approvals process for small local projects are usually directed through a local government process, which may be less onerous to the developer.

Grid connection agreement

Obtaining a grid connection agreement for a new wind farm requires invitation and approval by the local network provider. This in turn is usually the result of costly and time consuming grid connection studies which are usually conducted by the network service provider and are able to demonstrate that the wind farm does not adversely affect the stability and reliability of the transmission line to which it is connected. The grid connection agreement ranked as a high risk for four of the projects surveyed. This is an expected result, because the costs associated with connecting a wind farm are usually higher than required, due to the typical requirement for over-engineering, in order to provide the network service provider with a high degree of confidence in the electrical stability systems employed.

Construction agreement

The construction agreement process was regarded as a lower risk than that of construction itself, however ranked as a high risk. This supports the data from the interview question.

Wind monitoring and economic modelling

Wind monitoring and economic modelling were ranked by many projects as medium to high risk issues. Wind monitoring requires accurate calibrated instruments operating for a minimum period of 12 months in order to assess the wind resource. This process is fraught with potential error sources which may potentially bias the results upward or downward and is a science unto itself.

Further, the data obtained through this process is usually correlated to other local data sources to attempt to obtain a strong representation of the potential resource on site. This data is then used to assess the economic feasibility of the project based upon a number of assumptions including energy pricing, capital cost, inflation and timeframe.

The data and economic modelling process undertaken is usually carried out by an independent operator in order to provide the developer and financiers with a more objective view of the feasibility of the project.

The wind monitoring process and data is critical to the development process and the estimation of the long term wind resource is essential to the assessment of feasibility of the project (Raftery, Tindal & Garrad 1999).

Approvals and licensing

Closely aligned with the EIA process is the approvals and licensing process. Interestingly, the assessment of the approvals and licensing risk by the developers was rated similarly. The survey process did not discriminate between the type of approval or licensing risk, in which case the question could refer to federal, state, local approval processes, or licensing with the national electricity authority.

The variety of responses provided in the data may reflect the broad nature of the approval process and permitting authorities operating in the approval process.

Operations and maintenance

Operations and maintenance agreements and operations were considered a low to moderate risk by most projects excluding the Mawson Antarctic Project. Clearly the operations and maintenance function is of a lower priority to wind energy projects in comparison to that associated with power purchase and construction risk.

Land assessment and security

Land assessment and security were ranked as a low to moderate risks by all the projects, presumable because it is a relatively low cost, low input process that seems to be well understood. Land security risks are offset through the use of wind monitoring agreements, lease options and lease agreements. Only one project rated the land lease issue as a high risk, which may be attributable to the impacts of local community and neighbour concerns, landholder returns or the complications associated with the completion of legal documentation.

Finance

Debt and equity finance for a wind farm in Australia is considered a low risk. This is supported by the literature and evidence that funding for wind farming globally is available. This is especially frustrating for local developers, given that Australian fund managers are investing heavily in overseas wind farming portfolios (Rajgor 2006).

This section has described the ranking of the project development risks as prioritised by the research participants. This ranking is consistent with the information provided in the first part of the research, identifying the primary development risks. The next section will seek to describe the secondary risks as identified by the participants.

4.6 Secondary risks identified

During the interview process, participants were asked to mention some important development risks that had not been mentioned in the prior questions. These are listed in Table 4.4 below. The results are discussed below.

Table 4.4 Secondary development risks identified

Case Number	***Other Risks Identified***	***Code***
1	*Public opinion* *Competition* *Market*	*community* *competition* *market*
2	*no*	
3	*Public opinion* *PPA price reduction*	*community* *market*
4	*Environmental compliance* *Political risk MRET* *PPA price risk*	*compliance* *MRET* *PPA*
5	*Local content risk* *Vandalism* *Political risk/lobbying* *Media management*	*Local content* *Vandalism* *Political risk* *Media*
6	*Political risk* *Equipment lifetime and maintenance* *Safety risk during construction*	*Political risk* *Equipment* *Safety*
7	*Maintenance staff capability*	*Maintenance*
8	*no*	

Source: Developed for this research

A variety of development risks were identified through this process which had not been previously identified. These included public opinion and its management, changes to the market and the price of energy, competition, environmental compliance, local content, vandalism, political risk and maintenance risk. These are discussed in more detail below.

Public opinion

Negative public opinion is considered a risk to developers, since only a small number of objections have the capacity to prevent a project from proceeding. In general, public opinion against wind farms tends to be greatest prior to the development being constructed (Gipe 1995). After construction, negative public opinion tends to reduce. Negative public opinion can stem from a variety of factors, both founded and unfounded. It is therefore in the interests of developers to adopt proactive community consultation and participation processes early in the life of the project and continue throughout the life of the project, a process which has been adopted by similar industries such as mining.

Competition risk

Competition risk refers to the risk associated with competitive developers operating in the same geographic area, seeking the same network or grid connection, or competing for a power purchase agreement with the same, or similar utility, or competing for finance from the same or similar institution. In many areas of Australia where the wind resource is known to be strong, competition for land has been intense around areas where the grid is known to have sufficient capacity for extra generation. Competition for land drives up land values and hence increases development costs.

Market risk

Market risk relates primarily to the risk of the wind farm not gaining a power purchase agreement, nor gaining finance and is closely linked to competitive risk. Market risk also relates to the level of investor confidence and the quantity and quality of investor funds available in the marketplace for similar projects.

Environmental compliance

Environmental compliance defines the methods of environmental protection which govern the construction, operations and maintenance as dictated by the designated planning approval authority. Such compliance methods are usually predictable and managable, however there exists a level of risk and uncertainty that project developers need to consider in the scheduling and budgeting of large scale projects.

Perhaps of most concern to developers are the compliance requirements for native flora and fauna protection, cultural heritage, noise mitigation and electromagnetic interference prevention. These obligations are often unknown at the time of development application lodgement and prefeasibility, so therefore need to be accounted for within the total budget at a later stage prior to seeking of significant project funding.

Local content obligations

Under some approval and consent processes is a requirement for a certain quantity or value of local content, usually in terms of percentage of capital or total value. In areas with available resources and labour this is usually achievable, however in more remote locations, this may present a more significant risk to developers in the form of availability and/or cost of local resources.

Vandalism

The risk of vandalism to wind energy projects is not well understood, nor documented. Such acts of vandalism have been known to include wilful damage such as graffiti, damage from gun fire, and loosening of guy ropes from monitoring towers. Acts of vandalism have the potential to increase costs of maintenance and reduce returns from energy production, due to turbine down-time. Vandalism risk may be reduced by implementing increased security measures and insurances which in-turn increase maintenance and operational costs.

Political risk

The risk of political changes in legislation at the federal level has been explained previously. At the state and local level, political risk also exists in terms of changes to local planning policies, changes in community sentiment. This political risk may be better managed through the use of proactive community communication strategies such as lobbying and media utilisation.

Equipment failure

Equipment failure has the potential to reduce energy yields and consequent returns on the project. Equipment failure has occurred in several large scale projects to date, to the detriment of the projects and their viability. Equipment failure, such as gearbox failure has occurred even in large-scale offshore projects such as Horns Rev in Denmark (Moller, Jackson & Massy 2004). Such equipment failure represents a significant risk to developers. Consequently, developers often seek to mitigate against equipment failure risk by employing contracts such as warranty agreements, performance guarantees and liquidated damages for lost revenues against turbine manufacturers and other equipment suppliers (Mallesons Stephen Jaques 2004).

4.7 Risk management approaches

The previous section described the secondary risks identified by the research participants. This section now describes the approaches taken by organisations to reduce the risks identified in the research. Table 4.5 below lists the risk management approaches described by the respondents and then broadly classifies the approaches into common themes.

Table 4.5 Secondary risk management approaches identified

Case Number	*Risk Management Approaches*	*Theme*
1	*Due diligence* *Keep a realistic view of opportunities and act accordingly*	*Due diligence* *Proactivism*
2	*Use contingencies and discount factors* *Build O&M into capital cost*	*Conservatism* *Conservatism*
3	*Peer review of financial models*	*Due diligence*
4	*Internal vs external modelling analysis* *Long term data analysis* *Long term PPA* *Hedging of contracts (exchange rates)* *Site risk contingency factors* *Internal contract control* *Conservative O&M provisions*	*Due diligence* *Due diligence* *Conservatism* *Proactivism* *Conservatism* *Proactivism* *Conservatism*
5	*Utilise in-house expertise* *Lower risk exposure through utilisation of skills and experience* *Post-project peer review* *Documentation and record-keeping* *Management plans* *Contingency budgets*	*Proactivirty* *Proactivism* *Due diligence* *Due diligence* *Due diligence* *Conservatism*
6	*Peer review* *Long term O&M contracts* *Safety management plan* *Stakeholder management plan*	*Due diligence* *Conservatism* *Due diligence* *Due diligence*
7	*Construction Management plans* *Staff Training* *Hardware adaptation* *Internal project management*	*Due diligence* *Proactivism* *Proactivism* *Proactivism*
8	*Process and procedures* *Past learnings and experience*	*Due diligence* *Proactivism*

Source: Developed for this research

Most of the common risk management themes identified fall into a broad range of classifications which have been termed as due diligence, conservatism, and proactivism. Each of these approaches is explained in the following section.

Due diligence

Many of the risk management approaches identified fall into the category of due diligence. The term due diligence refers to the process of systematically evaluating information, to identify risks and issues relating to a proposed project. In this case due diligence refers to adherence to a management process and strong documentation to support each element of the development process.

Grouped within this category is the use of verification of particular types of important information from independent sources such as wind energy data and modelling. Also grouped within this category is the use of peer review processes to verify the information and models developed.

Conservatism

In risk management, to take a conservative view, is to attempt to estimate a cost or outcome, often with a contingency to allow for a worst case scenario. In this way, costs and timeframes are estimated taking into account any additional variations or on-cost which may result in a negative result and will produce a more negative result than that expected. Using such a conservative approach usually allows for better than forecast results, as some of the negative impacts may not eventuate. Examples of conservative approaches adopted include the use of contingency allowances, discount factors and worst case budget scenarios. Evidence of such conservative approaches include adopting long term power purchase agreements and factoring in the cost of operations and maintenance as a capital cost.

Proactivism

Proactivism is defined in this context, as taking an aggressive and active operational response to a potential development risk. An example of such proactive tactics adopted by organisations may include internalising contract controls to reduce costs, engaging skills and training development to improve internal knowledge, and actively responding to new market opportunities.

These three categories of risk management approaches align closely with Floricel and Miller's (2001) taxonomy of risk management strategies of information/selection, cooptation, allocation, design and action which were examined in the literature review.

This section has sought to describe the main categories of risk management approaches adopted by the project developments. The next section will outline the level of formality of structure utilised by the organisations.

4.8 Ranking the structure of the risk management strategy

In seeking to determine how structured the risk management process was, participants were asked to rank the formality of the risk management structure according to Table 4.6 (below).

Table 4.6 Risk management structure ranking

Risk Factor	Subcategory	Risk Management Strategy Rating
Prospecting	*Land assessment*	*None, informal, formal, highly structured*
Land Security	*Land Lease Option*	*None, informal, formal, highly structured*
	Land Lease	*None, informal, formal, highly structured*
Wind Resource	*Monitoring/modelling*	*None, informal, formal, highly structured*
Feasibility Studies	*Economic modelling*	*None, informal, formal, highly structured*
Development Application	*Environmental Impact Assessment*	*None, informal, formal, highly structured*
Licensing/Permitting	*Approvals and Licencing*	*None, informal, formal, highly structured*
Grid Connection	*Grid Connection Agreement*	*None, informal, formal, highly structured*
Power Purchase	*Power Purchase Agreement*	*None, informal, formal, highly structured*
Finance	*Debt*	*None, informal, formal, highly structured*
	Equity	*None, informal, formal, highly structured*
Construction	*Construction Agreement*	*None, informal, formal, highly structured*
	Construction operations	*None, informal, formal, highly structured*
Operation & Maintenance	*O&M Agreement*	*None, informal, formal, highly structured*
	Operations and Management	*None, informal, formal, highly structured*

Source: Developed for this research

Participant results were tabled by aligning the Likert scale with a 1-4 ranking where 1 equals no structure, and highly structured equals 4.

Table 4.7 Results of the risk management structure ranking

	Case							
Risk	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Land assessment	*3*	*3*	*3*	*2*	*3*	*3*	*na*	*3*
Land lease option	*3*	*4*	*4*	*3*	*2*	*2*	*na*	*3*
Land lease	*3*	*4*	*4*	*3*	*2*	*2*	*na*	*3*
Monitoring/modelling	*4*	*4*	*4*	*4*	*4*	*4*	*3*	*4*
Economic modelling	*3*	*4*	*4*	*4*	*4*	*4*	*3*	*4*
EIA	*4*	*4*	*4*	*4*	*3*	*3*	*3*	*3*
Approvals and licensing	*4*	*4*	*4*	*3*	*2*	*2*	*1*	*3*
Grid connection agreement	*na*	*4*	*4*	*3*	*3*	*3*	*3*	*4*
PPA	*na*	*4*	*4*	*4*	*4*	*4*	*na*	*4*
Debt/Equity Finance	*na*	*3*	*3*	*3*	*3*	*3*	*3*	*4*
Construction agreement	*3*	*4*	*4*	*4*	*3*	*3*	*na*	*4*
Construction operations	*3*	*4*	*4*	*4*	*3*	*3*	*3*	*3*
O&M Agreement	*3*	*4*	*4*	*na*	*3*	*3*	*na*	*4*
O&M	*3*	*4*	*4*	*3*	*3*	*3*	*3*	*3*

Source: Developed for this research

Table 4.7 (above) demonstrates that most of the issues described were covered by a formal or structured risk management approach (ranking 3 or 4). In general few issues were dealt with using informal or discrete management processes. This result indicates that formal risk management is a process which is utilised by the wind energy industry in Australia.

The next section describes the future risks perceived by wind energy developers in Australia.

4.9 Future risks

This section describes the future risks as identified by the research participants. Table 4.8 (below) lists the risks identified by the research participants, each then classified into general themes.

Table 4.8 Future risks identified by wind energy developers in Australia

Case Number	*Future Risks*	*Theme*
1	*Market mechanisms to support renewables* *Match between grid capacity and wind resource*	*Policy* *Grid/Resource*
2	*MRET* *Carbon trading* *Government commitment to renewable energy*	*Policy* *Policy* *Policy*
3	*MRET* *Government commitment to renewable energy*	*Policy* *Policy*
4	*Range of variables outside of industry control* *Finance risk/Interest rates* *Environmental performance and compliance* *Reliability of existing wind farms* *Availability of spare parts* *Reliability of O&M Agreements*	*General* *Finance* *Performance* *Performance* *O&M* *O&M*
5	*Political risk/energy policy* *Community support*	*Policy* *Community*
6	*Political risk/energy policy* *Community support*	*Policy* *Community*
7	*MRET*	*Policy*
8	*Politics/Policy* *Community acceptance* *Economics*	*Policy* *Community* *Economics*

Source: Developed for this research

The broad categories of future risks identified include policy, grid/resource, community, finance, economics, operations and maintenance. Each of these categories are discussed below.

Policy

All participants described the greatest future risk to wind energy development as policy, particularly with respect to the Mandatory Renewable Energy Target (MRET). Other policy matters included the potential for carbon trading and a general need for strengthening of renewable energy policies. The policy risk reflects the general lack of security and confidence in the present federal government commitment toward renewable energy.

Grid resource constraints

The matching of the capacity of the electrical transmission grid to the available wind resource is a technical risk which is best approached through thorough site selection procedures.
It is questionable whether the government will be providing incentives for the transmission operators to upgrade transmission capacity in areas where wind generation is considered viable. This type of action would however, improve the possibility of increasing the capacity of existing wind farms in particular areas constrained by the transmission capacity.

Finance risk and interest rates

At present, the availability of finance to viable wind farms is not considered a major risk, however should the marketplace change and interest rates increase, the availability of finance for wind energy projects will be reduced.

Environmental performance and compliance

The performance of large-scale, long-term wind energy projects in Australian conditions is not well understood. Despite the availability of long term weather data, resource modelling does not necessarily capture variations in long term wind patterns, such as those experienced in Germany recently (Milborrow 2005, p.1). Therefore questions may need to be asked to determine whether the projects are meeting the expectations of stakeholders with respect to performance criteria in terms of energy production and commercial viability, but also in terms of the compliance criteria relating to noise, electromagnetic interference, as well as bird and bat kills.

Operations and maintenance

The major future risks associated with operations and maintenance relate to project performance (mentioned above), the risk of breakdown of machinery and also the availability and cost of spare parts, labour and trained personnel. Time will also test the robustness of the operations and maintenance agreements that are in place with O&M contractors, the turbine manufacturers and balance of plant suppliers.

Community stakeholder risk

Community risk is the final risk identified by respondents as a future risk consideration. Given the other risks mentioned above, the quality of the performance of wind energy projects will reflect the level of future support or otherwise afforded by community stakeholders. Without adequate community support, wind energy projects are unlikely to progress to commissioning, and without performance results, future projects are jeopardised. Community stakeholders expect developers to adhere to compliance levels and minimise and mitigate against impacts associated with the project development. If project developers continue to liaise and consult with community stakeholders throughout the life cycle of these projects then local acceptance will improve and future developments be more streamlined.

This section described the future risks to wind energy development in Australia as identified by the respondents. The next section describes the strategies to address these future risks, as identified by the research participants.

4.10 Addressing the future risks

This section is the final component of the analysis of case studies and describes how developers should address the future risks to wind energy development in Australia.

Participants were asked, *How should the future risks be addressed to increase the chance of project success*? Table 4.9 (below) lists the responses and then categorises them into themes. A number of recurring themes were identified, being lobbying, economics, policy, education and demonstration. Each of these is described individually below.

Table 4.9 Addressing the future risks to increase the chance of success as suggested by wind energy developers in Australia

Case Number	***Methods to Address Future Risks***	***Theme***
1	*Lobbying government regulators to secure market mechanisms* *Lobby to modify technical aspects of the electricity market to allow increasing amounts of wind penetration.*	*Lobbying* *Lobbying*
2	*Be certain of the offtake market and forward pricing forecasts.* *Ensure appropriate contingencies are allowed for especially wind speeds and capital costs*	*Economics* *Economics*
3	*As above*	
4	*Need for government to take a longer term view* *Need to push ahead with the better projects and hold off on less feasible projects* *Need to provide decommissioning funds for project removal and/or retrofitting*	*Policy* *Economics* *Economics*
5	*Need to engage with politicians at every level using well known environmental champions and "in your face" campaigns like those used in the UK*	*Lobbying* *Education*
6	*As above*	
7	*Need to lobby to increase MRET* *Need to use industry associations to lobby* *Direction for future investment needs to come from government* *Need to lobby and educate associated energy industries such as coal mining and nuclear on the benefits of wind*	*Lobbying* *Lobbying* *Policy* *Lobbying/Education*
8	*Need for continuous(longer term) and consistent policy* *Need for education for community acceptance* *Need to demonstrate environmental and economic sustainability*	*Policy* *Education* *Demonstration*

Source: Developed for this research

Lobbying and policy

According to the developers the industry needs to lobby every level of government to ensure greater security and tenure of policy. In addition government regulators need to be lobbied to secure the market mechanisms such as MRET, and to allow greater wind penetration of the existing generation market as has occurred in other countries. In the case of the MRET this lobbying should be to increase the percentage of renewable generation and lengthen the timeframe beyond 2020. Further it is suggested that the wind industry should work with other associated and competitive industries such as coal and nuclear to encourage wind energy adoption alongside traditional and newer generation technologies.

Education

Closely aligned with lobbying and policy is the precursory theme of education. Participants suggested that educational campaigns such as the UK wind industry's "Embrace Wind" have been successful in generating community support for wind energy. This proactive community support has led to policy changes at a number of levels in the UK market.

Economics

Some participants described the need for economic expectations of projects to be more realistic based upon the existing market conditions. Whilst it is difficult to forecast future power prices, it seems reasonable to make a number of assumptions which would quickly reduce the viability of a number of projects around Australia due to marginal wind resources and limitations of grid capacity. This then allows for the introduction of contingency factors to offset the risk factors associated with such unknowns. Participants suggested that contingency factors should be allowed for power price, wind speed, capital cost and decommissioning.

Demonstration

One participating developer suggested that the industry needs to be able to demonstrate that the claims made by developers are true, and that the industry has a responsibility to demonstrate economic and environmental sustainability of the industry.

4.11 Conclusion

This chapter has described the findings of the case study analysis through the process of case description and cross case study analysis. Participants to the research identified the primary, secondary and future risks associated with wind energy development in Australia. The importance of these risks was verified by a rating against the other known risks. A description of these risks was provided with suggestions for future actions to reduce the future risks.

The primary development risks as identified by the participants were:

- The Mandatory Renewable Energy Target (MRET) Legislation
- Community Concerns
- Grid Connection Issues
- Planning Issues
- Energy Generation Issues
- Sales-Offtake/Power Purchase Issues
- Construction Issues
- Operations and Maintenance Risks

Interestingly, the risks associated with construction, operations and maintenance were ranked more highly than expectations. This result was verified using the Likert-Scaled questions.

The secondary development risks as identified by the participants included:

- Public Opinion
- Competition Risk
- Market Risk
- Environmental Compliance
- Local Content Obligations
- Vandalism
- Political Risk
- Equipment Failure

Contrary to the expectations, most developers adopted a formal or highly structured approach to risk management issues within a formal project management process.

The future development risks as identified by the participants included:

- Policy
- Grid/Resource Constraints
- Finance Risk & Interest Rates
- Environmental Performance and Compliance
- Operations and Maintenance
- Community Stakeholder Risk

The methods for addressing these future risks were identified as comprising:

- Lobbying and Policy
- Education
- Economics
- Demonstration of project success.

This concludes the Analysis of Findings chapter. The next chapter seeks to link the findings to the Literature Review.

5 Chapter Five - Linking the Analysis of Data to the Literature Review

5.1 Introduction

The previous chapter described and analysed the findings from the data collected during the interview process. Using case study analysis techniques, including cross case analysis methodologies (Eisenhardt 1989; Yin 1989, 1993, 1994), broad findings regarding risk management within and between wind energy projects were obtained and reported. This process identified the primary, secondary and future development risks associated with wind energy development in Australia, and provided a range of potential methods to address the risks as identified by the participants.

This chapter now links the analysis of findings to the themes of the literature review and highlights the expected and unexpected results of the research. The themes identified through the literature review will provide the focus for this analysis. The Analysis of Findings will provide a greater insight into the themes identified through the literature review as well as broadening the discussion to other types of project management, megaprojects and the renewable energy industry in general.

5.2 The literature review of parent disciplines

The literature review identified the research project as lying within the key parent disciplines of project management and risk management. For the purpose of this research, wind energy projects are considered large scale infrastructure projects which follow a rigorous project management sequence (Nokes et al. 2003; PMBOK 2004), given the requirement for significant amounts of capital and financing.

Wind energy projects follow the typical project life cycle suggested by Nokes et al. (2003, p.17). It is logical that banking and finance institutions which service the wind energy industry with debt and equity funding, will follow the rules and processes associated with more traditional project development and consequent due diligence requirements.

Within project management, risk management is one of the nine key project management knowledge areas (PMBOK 2004, p.11). Nokes et al. (2003, p.17) also describes risk management as one of the project management processes. Then, in turn, within the knowledge area of project risk management, Nokes et al. (2003, p.123) identified the three typical risk sources as deriving from business, project and task risk.

The latest Standards Australia Risk Management Manual (AS/NZS 4360 2004) provides a more in-depth description of the risk management process.

5.3 Risk defined

For the purposes of this research, risk was defined by AS/NZS 4360 2004 (p.3) as:

> *the chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood*.

From the research it appears that the definition of *risk*, and how the various risks influence the development of wind energy projects appear to be well understood. No participants required any further clarification of the definition or meaning of the term *risk*. This might also indicate that most of the participants were from a project management background.

5.4 The risk management process

Similarly, it appeared that most participants were familiar with the risk management process as it applied to the development of wind energy projects. From the participant responses, there were few development risks identified that sat well outside those identified in the development risk register (Finlay-Jones 2004). It appeared that the participant organisations adopted mechanisms to allow identification, assessment and evaluation of the risks proposed, with suggestions for methods of risk treatment.

Barber (2004) suggested that significant project risks are often not adequately identified, analysed or managed. Within the scope of this research project, it appears that the major project risks have been identified, analysed and managed adequately.

However Barber also suggests that many of the internally generated risks are not adequately identified, analysed and managed. The issue of the cumulative effects of risks also appear to be missing from the data obtained. The integration of the risk management process within the project management functions appears to be evident from the research.

In comparison to the findings of Lyons and Skitmore (2004), in a survey of project risk management in the Queensland construction industry, it was found that:

- The use of risk management is moderate to high, with very little differences between the types, sizes and risk tolerance of the organisations.
- Risk management usage in the execution and planning stages is higher than in conceptual or termination phases.
- Risk identification and risk assessment are the most often used risk management elements ahead of risk response and risk documentation.
- Qualitative methods of risk assessment are used most frequently, ahead of quantitative and semi-qualitative methods.
- Risk reduction is the most frequently used risk response method followed by risk transfer; risk elimination and risk retention – with the use of contingencies and contractual transfer preferred over insurance.
- Project teams are the most frequent group to be used for risk analysis, ahead of in-house specialists and consultants. The level of specific risk management training within the construction project management industry is low to moderate
- The use of computers is consistently lower for risk management than for cost accounting, databases or scheduling. The recording of use of historical risk data is also low to moderate, along with the usage of such risk data on other projects.

By comparison, this research found that in the wind energy industry in Australia, risk management strategies vary.

The use of risk management in wind energy developments is moderate to high, however the types, sizes and risk tolerances of the organisations vary dramatically depending upon the scale and difficulty of the project and the size of the parent.

Of the projects surveyed in this research, the majority of organisations are larger, more experienced developers and possibly therefore have more resources than smaller entrepreneurial developer organisations.

Risk management usage in the execution and planning stages is higher than in the operational and maintenance stages. This is logical given the majority of the risk is associated with the high capital input required at construction, which requires a great deal of physical, financial and environmental planning. However it was mentioned by one developer that the performance implications have not yet been assessed adequately in Australia, given the early life stage of most projects.,

Risk reduction is the most frequently used risk response method followed by risk transfer; risk elimination and risk retention – with the use of contingencies and contractual transfer preferred over insurance Risk reduction is commonly cheaper, easier and more preferred than other mitigation strategies, depending upon the types and scale of risk.

Project teams are the most frequent group to be used for risk analysis, ahead of in-house specialists and consultants. The level of training in risk management techniques is low to moderate. For the projects surveyed, these organisations tend to internalise their project management function rather than outsource. In-house specialists usually have a specific skill area which potentially limits their knowledge in other areas. Consultants are often used for studies and assessment requiring a level of independence and bankability to financial institutions or other significant stakeholders such as consent authorities.

The use of specific risk management software is lower than those used for such activities as cost accounting, databases or scheduling. The recording of use of historical risk data is also low to moderate, along with the usage of such risk data on other projects.
The projects surveyed tended to use and adapt spreadsheets and documents for risk management purposes. Some organisations used past values and indicators for new projects and adopted a more knowledge based approach to risk management.

Similarly to de Lomos et al. (2004), the research found that environmental and social risks were often more difficult to assess and manage and were consequently less well assessed and managed.

5.5 Organisational attitude to risk

In the assessment of the attitude of organisations to project risk, Piney (2003) found that many factors influence this attitude and the consequent strategy by which to approach each risk. The major factors found in this research included the scale and difficulty of the project, and the size and financial condition of the parent company.

Despite being more economically viable, larger wind energy projects are typically more risky due to the level of investment required in the planning, monitoring and approval processes. In addition larger projects usually involve more stakeholders, more environmental impacts and a greater level of consent. Such risks are more easily borne by larger, more stable and more resource rich organisations. It is logical to assume then that as the industry develops, successful organisations will grow in financial stature and capacity, and will be prepared to accept the greater risk associated with larger and more difficult projects, provided the reward is realisable

5.6 A taxonomy of risk management strategies

According to Floricel and Miller (2001), project risk-management approaches can be grouped into two streams. The first is quantitative sensitivity analysis and probabilistic approaches, using scenario analysis, decision trees and influence diagrams. The second is a qualitative approach which seeks to identify events that may affect projects and then finds ways to mitigate against such risks. Floricel and Miller (2001), identified five classes of strategies to deal with anticipated risks (see Table 2.2). These strategies are defined as information/selection, co-optation, allocation, design and action.

This research found three major categories of strategies to deal with anticipated risk, namely conservatism, due diligence and proactivism.

Two of these three categories of strategies are strongly aligned with those from Floricel and Miller (2001) as shown in Table 5.1 (below), however the use of *conservatism* describes more of an attitudinal approach to the risk, rather than a specific strategy:

Table 5.1 Strategies to deal with anticipated risk

Information/selection. Approaches used to gather information and shape the project concept	**Due Diligence** Information gathering/prefeasibility
Co-optation Approaches used to obtain the required competencies and secure access to resources	**Proactivism** Competency development/resource security
Allocation Use of contractual clauses to apportion rewards, risks and responsibilities between participants	**Conservatism** Contracts and agreements/risk and responsibility allocation
Design Use of project concept elements to reduce the likelihood and impacts of risks	**Due Diligence** Risk identification/assessment/mitigation
Action Use of actions to reduce the likelihood of opposition or remove obstacles to project development	**Proactivism** Removal of barriers and impediments to project development

Source: Adapted from Floricel and Miller (2001) for this research

Due diligence

Many of the risk management approaches identified fall into the category of due diligence. The term due diligence refers to the process of systematically evaluating information, to identify risks and issues relating to a proposed project. In this case due diligence refers to adherence to a management process and strong documentation to support each element of the development process. Grouped within this category is the use of verification of particular types of important information from independent sources such as wind energy data and modelling. Also grouped within this category is the use of peer review processes to verify the information and models developed.

Conservatism

In risk management, to take a conservative view, is to attempt to estimate a cost or outcome, often with a contingency to allow for a worst case scenario. In this way, costs and timeframes are estimated taking into account any additional variations or on-cost which may result in a negative result and will produce a more negative result than that expected.

Using such a conservative approach usually allows for better than forecast results, as some of the negative impacts may not eventuate. Examples of conservative approaches adopted include the use of contingency allowances, discount factors and worst case budget scenarios. Evidence of such conservative approaches include adopting long term power purchase agreements and factoring in the cost of operations and maintenance as a capital cost.

Proactivism

Proactivism is defined in this context, as taking an aggressive and active operational response to a potential development risk. An example of such proactive tactics adopted by organisations may include internalising contract controls to reduce costs, engaging skills and training development to improve internal knowledge, and actively responding to new market opportunities.

This research clearly identified three different approaches to risk management adopted by wind energy developers in Australia. It is likely that the approaches of due diligence, conservatism and proactivism are used to mitigate against risk in many types of industries and projects. These broad general strategies may provide some assistance to other project management organisations that are seeking to manage their risk portfolio.

5.7 Megaproject risks

A number of significant risks were identified by Flyvbjerg, Bruzelius and Rothengatter (2003) in relation to the development of large scale projects internationally. A comparison of these risks to the findings of this research is provided in Table 5.2 below.

Large and cumulative wind energy projects can often be considered Megaprojects due to their sheer scale, capacity, impact on the landscape, infrastructure and investment requirements. An Irish based developer, Airtricity has recently announced its preliminary plans to develop a large scale offshore string of wind energy projects in the North Sea totalling approximately 10,000 MW of installed capacity, valued at approximately US$2M per MW. This type of plant would require further massive investment in grid connection infrastructure (Knight, 2006 p61)

Table 5.2 Megaproject risks and a comparison with wind energy developments

Megaproject Risks	**Wind Energy Industry Findings**
the poor performance in terms of economy, environment and public support;	Some poor performance evidence in noise, bird and bat kills; Public support high
the reduced level of community and stakeholder trust;	Public support high
massive cost overruns due to poor demand and cost estimation techniques;	Relatively few cost overruns to date
insufficient recognition of interest rate and currency exchange fluctuations;	Hedging of interest rates, exchange rates and currency fluctuations
developer overoptimism and accountability issues;	More realistic expectations of output
poor cumulative and indirect impact assessment techniques;	Some issues associated with cumulative and indirect assessment techniques
limited monitoring and auditing of impacts during operations;	Greater accountability for ongoing environmental performance monitoring
the high cost of environmental protection;	Some issues with environmental protection
inaccurate overestimates of regional economic benefits;	Realistic estimates of regional economic benefits
poor risk management techniques within development organisations;	Improved risk management techniques within development organisations
inadequate and misleading information regarding project development risks;	Generally adequate and realistic information regarding project development risks
under-informed and dysfunction stakeholder and community groups;	Strong functionality between pro and anti stakeholder and support groups.
questionable and conflicting roles of government as developer and guardian of public interest;	Reduced government role as developer, more clear roles for government as consent authority
poor regulatory and development approval regimes;	Some issues with regulatory and approval regimes
rent-seeking behaviour by special interest groups.	Some rent-seeking behaviour by special interest groups

Source: Adapted from Flyvbjerg, Bruzelius and Rothengatter (2003) for this research

In comparison to the megaprojects referenced by Flyvbjerg, Bruzelius and Rothengatter (2003), the performance of the wind energy industry in delivering successful projects appears to be more accountable and more reliable. Perhaps this has occurred due to the 30 years of experience of the industry, the ability for the industry to share data and information, and the understanding of its need for accountability to the wider community in order to continue its progress.

This section has addressed the primary parent disciplines of project management and risk management and has sought to link the literature to the findings of the research. The research confirmed the use of risk management processes within the project management function by development organisations. The research also confirmed the variation in attitude to risk by particular organisations dependent upon a range of factors associated with the development organisation and the proposed project. The research also identified the relatively strong performance of the surveyed projects against recent literature suggesting poor performance of many large scale megaprojects.

The next section will investigate the immediate discipline of wind energy project development risks and link the literature review to the findings of the research.

5.8 Wind energy project development risks

This section of the chapter will explore the relationship of the literature specifically associated with wind energy development to the findings of this research project. This section will examine the primary commercial, environmental and social risks associated with wind energy projects and divide them into global, regional and local perspectives. This follows the key subject areas of the literature review and relates these subject areas to the results from the research findings.

5.8.1 The global risks

The primary global risks identified by Finlay-Jones (2004) are included in Table 5.3 (below). These are compared against the findings for the research project as follows:

Table 5.3 Global risks and a comparison with findings

Primary Global Risks	Findings for Australian Wind Projects
International agreements and treaties	Low impact of Kyoto Protocol and Asia Pacific Partnership on Clean Development and Climate
Substitute renewable and other energy technologies	Impact of alternative renewables esp biomass and biodiesel Revived nuclear debate
The potential increase in community dissatisfaction with wind energy	Low levels of community dissatisfaction with wind energy
Significant changes to weather and wind patterns (global warming)	Unknown
Volatility of resource markets	Increases in fossil fuel prices (coal and oil)
Relatively low prices of fossil fuels	Wind still unable to compete effectively against coal-fired power
Developing country opportunities	Rapid market development in Asia esp China and India

Source: Adapted from Finlay-Jones (2004) for this research

International agreements and treaties

According to the findings, Australia's inability to ratify the Kyoto Protocol has severely hampered the development of the wind energy sector in Australia. At the time of writing, the Asia Pacific Partnership on Clean Development and Climate has also failed to increase the investment in the Australian wind energy sector.

Substitute renewable and other energy technologies

The risk of wind energy being substituted by other traditional energy sources was reported to be decreasing by Gipe (1995), however recent literature suggests that the commitment to nuclear power is increasing in places such as the UK due to its low greenhouse emission potential (Harrison & Milborrow 2006; Massy 2006). This potential risk has come to light since the research was carried out, and was not mentioned by any of the participants. Further, it is reported that nuclear energy is not well suited to integration with wind energy due to the inflexible generation capacity of nuclear power stations (Harrison & Milborrow 2006; Massy 2006). This section demonstrates the rapidly moving energy debate between traditional energy sources and the renewable energy sector. It also demonstrates the risk associated with nuclear energy being selected as a preferred base load, and the consequent ability for wind energy projects to succeed being potentially hampered.

Other methods to reduce greenhouse emissions

The coal industry in Australia is presently investigating mechanisms to reduce emissions from coal, such as clean coal technology. Such mechanisms include reduced emissions from improved filtering of smoke, capturing of emission gases and storage of emissions through geosequestration.

The oil and gas industries are also investigating methods to reduce emissions from the burning of oil and gas. Royal Dutch Shell for example is trapping carbon dioxide and pumping it into greenhouses for improved flower production (Mouawad 2006).

Increasing cost of wind power

Identified in the literature review, and briefly touched on by a number of participants, the issue of the increasing cost of wind power has become a hot topic. Due to the increasing demand for wind turbines in Europe, the US and parts of Asia, wind turbine manufacturers have increased the price of turbines to reflect the new market conditions. Further, the demand has also increased the lead time associated with turbine delivery (Moller & Mathews 2006).

Community acceptance

Despite indications from Gipe (1995, p.250), that there is a general lack of community acceptance for wind energy, recent surveys by the BWEA recent figures suggest that in the UK for example,

> *85% of the general public support the use of renewable energy, 81% are in favour of wind power and just over three-fifths would be happy to live within five kilometres of a wind power development* (Massy 2006).

In Australia, recent research (AC Nielsen 2006) suggests;

- the vast majority of Australians are concerned about environmental issues and climate change
- Almost all (93%) of Australians surveyed had heard of climate change
- The majority of Australians believe there is a need to reduce greenhouse gases, and that Australia should be a leader in the reduction of greenhouse gases

The research indicates that a relatively low level of community dissatisfaction against wind energy projects exist, considering the rapid growth of the industry globally.

Significant weather changes and global warming

Whilst the existence of climate change appears to be accepted (Flannery 2005; Stix 2006), particularly given the commitment of the signatory nations to the Kyoto Protocol, the implications of weather changes due to the effects of climate change are less well documented.

It is apparent that long term weather data collected in Denmark and Germany indicate the reduced strength of wind resource over the past 20 years, relative to the past 140 years (Milborrow 2005). Whether this reduction in recent wind speeds is related to global warming is not yet understood.

It could be argued that global warming may cause the effects of increased variability of wind speeds and increased severity of extreme wind events. If these effects do occur, this will reduce the efficiency of the projects and increase the risk associated with the reliability of the wind resource and hence energy production.

Volatility of resource markets

Recent volatility of resource markets, particularly minerals and fossil fuels, represents both an opportunity and a risk for renewable energy technologies. The price of copper and steel as components for wind turbines has also contributed to the increasing price of wind turbines, increasing the risk for developers.

The research indicates that the increasing pricing associated with traditional energy sources is having a favourable effect on the wind energy sector.

Relatively low prices of fossil fuels

The price of fossil fuels for energy production is considered low relative to the price of wind energy projects, however wind energy is increasingly being installed in countries recognising the increasing prices and availability of traditional energy sources. The research indicates that wind energy has a limited capacity to compete against lowly priced of fossil fuel derived energy sources, particularly in Australia. The evidence suggests that wind energy will continue to be installed where fossil fuel prices continue to rise. In the UK, the Renewables Advisory Board (RAB) report states that wind energy reduces fuel costs to customers, with savings increasing as the cost of fossil fuel rises (Wind Wire: Britain against nuclear 2006, p.8).

Developing country opportunities

The literature review identified the opportunities for wind energy in developing countries. In particular, China and India have been identified as strong markets for wind energy development, with wind turbine manufacturers seeking to establish manufacturing facilities to satisfy local market demands ('Company results' 2006, p.40, 43). The research supported the fact that wind energy projects are more likely to be developed in countries where government and market support systems are in place.

This section has sought to link the literature review to the research findings for the global risks identified. The next section will examine the link between the literature and the research findings for the national risks identified.

5.8.2 National risks

The national risks identified through the literature review included legislation, policy mechanisms, and electricity market reform. Each of these will now be discussed as they link to the research findings.

Legislation

The literature review identified a number of examples of supportive legislation which provide a platform for viable wind energy project development. This method of promoting wind energy development was strongly supported by the research.

Specific policy mechanisms

The literature review also identified examples of specific policy mechanisms favouring renewable energy. The research findings also supported such mechanisms as mandatory renewable energy targets.

Electricity market reform

The literature review identified that in certain markets the access of wind energy projects to existing electricity and energy infrastructure is limiting. The research findings confirmed that barriers to development included limited access to the electricity transmission grid, the high costs associated with generation licensing and the disproportionate responsibility of wind energy projects to fund infrastructure augmentation.

5.8.3 State and regional risks: State based incentives

The literature identified the primary state and regional risk as being the lack of renewable energy incentives and standards. The research findings supported the use of renewable energy incentives, however the effectiveness of state based systems in Australia to date are questionable.

Further the issues associated with state based approval and licencing systems were identified by the literature review and confirmed by the findings.

The issue of generation licensing, and the licensing requirement obligations on developers in South Australia, were risks specifically identified by the literature review and confirmed by the project developers located in this state.

Due to limitations of availability of access to developers, the research did not include projects within the state of Victoria nor the Northern Territory. Consequently, for Victoria in particular, the issue of local community dissatisfaction with wind energy projects was not more fully examined.

This section has described the national and state risks associated with wind energy projects as identified through the literature review and has confirmed the importance of these issues through the research findings. The next section will describe the local project risks as identified through the literature review, and compare them to the research findings.

5.8.4 Local project risks

Floricel and Miller (2001) identified that large scale projects potentially face several classes of risks: sponsorship/development, market, social acceptability, regulatory and political, financial, execution and operation. This section will describe the local project risks as identified through the literature review and link these with the research findings.

Through the literature review process a broad variety of local project development risks were identified (see table 5.4 below) for wind projects in general.

Table 5.4 General classification of risks associated with wind energy projects

Risk Factor	**Subcategory**	**Risk Stakeholders**
Prospecting	*Land assessment*	*Developer*
Land Security	*Wind Monitoring Agreement*	*Landholders/Developer/Legal advisors*
	Land Lease	*Landholders/Developer/Legal advisors*
Wind Resource	*Monitoring/modelling*	*Developer/Contractors*
Feasibility Studies	*Economic modelling*	*Developer/Contractor*
Development Application	*Environmental Impact Assessment*	*Developer/Contractors*
Licensing/Permitting	*Approvals and Reporting*	*Developer/State agencies/local govt*
Grid Connection	*Study/Agreement*	*Developer/Contractor/Network Service Provider*
Power Purchase	*Power Purchase Agreement*	*Developer/Utility/Legal advisors*
Finance	*Debt*	*Developer/Institution/Legal advisors*
	Equity	*Developer/Shareholder/Institution/Legal advisors*
Construction	*Construction Agreement*	*Developer/EPC/Turbine manufacturer/Shareholders/Legal advice*
Operation & Maintenance	*O&M Agreement*	*Turbine manufacturers/entity*
Decommissioning	*Decommission Agreement*	*Entity/Subcontractor*

Source: Finlay-Jones (2004)

Through the research process, these risks were confirmed, with mention being afforded to the legislative incentives, community concerns and grid connection issues. This is confirmed through the literature by Raftery, Tindal and Garrad (1999) and Flyvbjerg, Bruzelius and Rothengatter (2003), particularly with respect to the community concerns associated with megaprojects.

In the ranking of these local risks, however the research participants also ranked the economic modelling risk, sales/offtake risk, and construction operations risk as high.

The risks not identified in the schedule provided, but identified by the research included:

- negative public opinion
- market and competition risk
- environmental compliance
- local content obligations
- vandalism
- equipment failure

When considering the types of risk management undertaken by wind energy developers in Australia, the research indicated that most wind energy developers adopted formal or highly structured risk management strategies. It is not clear from the findings however as to the types of risk management strategies adopted eg qualitative vs quantitative. This is a case for future research.

This section has linked the local project risk management findings to the literature review and has found some consistent results. Of particular interest are those findings which were not identified by the literature review including environmental compliance and vandalism. The next section will examine the future risks identified through the research process.

5.8.5 Future risks

The future risks identified by the research participants included:

- government policy and legislation
- grid/resource constraints
- finance risk and interest rates
- environmental performance and compliance
- operations and maintenance
- community stakeholder management

These risks may then be addressed by attention to:

- lobbying and policy development
- education
- realistic economic expectations
- demonstration of project and community expectations

5.9 Conclusion

This chapter has described the linkages between the literature review and the research findings for the project. Generally, the findings from the research were consistent with the literature in terms of the practice of risk management procedures. Wind energy developers in Australia undertake risk management identification, assessment and mitigation within a project management framework. These developers have formal and highly structured internal methods of risk assessment and management. There are many risks associated with wind energy project development in Australia however, the nature of the federal renewable energy legislation presently represents the greatest risk to the future of further development. For those projects already constructed, significant risks include on-going sales and off-take agreements and operations and maintenance management. Developers were able to describe a range of risks not previously identified by the literature review, as well as provide ideas for future directions in order to reduce the impact of perceived future risks.

The next chapter will draw a number of broad conclusions concerning the research problems by answering the research questions. Chapter 6 will also discuss the implications for theory, policy and practice of the development of renewable energy projects in Australia.

Further, this chapter will describe the limitations associated with the research project and will conclude by providing a basis for further research.

6 Chapter Six - Conclusion

6.1 Introduction

The previous chapter described the linkages between the literature review and the research findings for the project. This chapter will draw a number of broad conclusions concerning the research problems by answering the research questions. This chapter will also discuss the implications for theory, policy and practice of the development of renewable energy projects in Australia as well as the impacts for international climate change and global warming.

Further, this chapter will describe the limitations associated with the research project and will conclude by providing a basis for further research.

6.2 Conclusions about the research problem

The research problem identified for this research is the management (identification, assessment and minimisation of exposure) of risks associated with the development of wind energy projects in Australia.

The research question is then:

> *How can the project management function of the development process of wind energy projects minimise the associated risks?*

Put another way the research sought to; *identify, assess and minimise the risks associated with the development of wind energy projects in Australia*.

In order to answer this question, the thesis first explored and analysed the literature to determine the existing theories and processes associated with the research question. The literature was investigated according to the parent disciplines of project management, risk management and wind energy project development.

These theories were then integrated into a series of themes, developed into research questions which were:

- *What are the main risks associated with wind energy development in Australia?*
- *How are these risks managed by the organisation?*
- *How are these risks ranked relative to each other?*
- *What other risks exist that are important?*
- *What are the approaches adopted to reduce these risks?*
- *What type of risk management strategies are adopted by project developers?*
- *What are the future risks for the industry?*
- *How should these future risks be addressed?*

These research questions were then used as a basis for the exploration of the existing literature. It was evident that there was a lack of literature which applied to the wind energy industry in Australia. However strong literature evidence was available for project management and risk management theory across other industries including construction. Each of these research questions will now be discussed in terms of the contribution to current theory.

6.3 The main risks associated with wind energy project development in Australia

The primary risks associated with wind development in Australia were consistently identified by the research participants as:

- the limitations of the present federal renewable energy policy and Mandatory Renewable Energy Target (MRET)
- local community concerns with wind energy development
- transmission grid connection issues
- development planning restrictions
- energy generation constraints
- sales-oftake/power purchase issues
- construction issues
- operations and maintenance risk

The presence of these risks was confirmed by the evidence from the literature, however the level of recognition of the contribution of these risks is limited.

6.4 How are these risks managed by the organisation?

In order to answer the research question, it is necessary to investigate the methods of managing the risks identified. This is summarised in Table 6.1 (below):

Table 6.1 Risk management strategies adopted by wind energy developers

Primary Risk	Risk Element	Mitigation Strategies	Theme
MRET	Low (2) percent Short term (2010)	Lobbying Policy	Proactivism Proactivism
Community concerns	Local community resistance	Education Consultation Participation	Proactivism Due diligence Proactivism
Grid Connection Issues	Insufficient capacity Cost of grid connection process Technology issues	Augmentation Capital budgeting Studies (R&D)	Conservatism Conservatism Due diligence
Planning restrictions	Planning constraints Planning fees Planning uncertainties	Planning preparation Understanding of regulations and requirements Lobbying & education	Due diligence Due diligence Proactivism
Generation constraints	Reliability of monitoring data Reliability of economic modelling Reliability of equipment	Improved independent monitoring Improved modelling R&D	Due diligence Due diligence Due diligence
Sales Offtake/PPA Risk	Duration/Price Terms and Conditions	Long term contract for power purchase Alliances with other organisations	Conservatism Proactivism
Construction Risk	Time delays Interface management Logistics OH&S Labour and resource availability	Contractual agreements eg EPC Use of specialist contractors Planning and forecasting	Due dliligence Due diligence Due diligence
Operations and maintenance risk	Labour and resource availability Technology failure Cost	Warranty Operations and Maintenance Agreement (WOM) Hedging	Due diligence Conservatism

Source: Adapted for the research project

Understanding that these risks are highly significant to developers, the research project then prioritised the key project development risks.

6.5 How are these risks ranked relative to each other?

Each of the identified risks identified, hold more or less importance to the developer depending upon the type of project, its location and size, as well as the state/region/locality in which it is proposed and the attitude of the developer to certain risks.

From the participant responses, in order of priority, the risks are prioritised according to Table 6.2 (below):

Table 6.2 Risk priorities according to wind energy developers in Australia

Risk Element	Ranking
PPA	4.0
Construction operations	3.9
EIA	3.4
Grid connection agreement	3.3
Construction agreement	3.1
Monitoring/modelling	3.0
Approvals and licensing	3.0
Economic modelling	2.8
O&M	2.8
land lease option	2.6
O&M Agreement	2.3
Land assessment	2.1
Land lease	1.9
Debt/Equity	1.5

Source: Adapted for the research project

It is apparent from this ranking that the power purchase agreement is the most important risk associated with the standardised project risks presented. This would be in direct correlation with the concern over the MRET, given the association between the power price and the impact of the MRET in the Australian market.

Also of interest are the high rankings of the construction operation risk and the risk associated with the environmental impact assessment process.

6.6 What other risks exist that are important?

The secondary risks identified by the research participants, beyond those presented as standard risks include:

- negative community opinion
- competition risk
- market risk
- environmental compliance
- local content obligations
- vandalism
- political risk
- equipment failure

The ability for the developers to identify these risks demonstrates that developers are thinking about and implementing risk management strategies.

6.7 What are the approaches adopted to reduce these secondary risks?

For the secondary risks identified a number of risk management strategies were adopted as noted in Table 6.3 (below):

Table 6.3 Secondary risk management strategies identified

Secondary Risks Identified	***Risk Management Strategies***	***Theme***
Negative community opinion	*Early intervention*	*Proactivism*
	Ongoing consultation	*Proactivism*
	Community participation	*Proactivism*
Competition risk	*Early access to land, resources and equipment*	*Proactivism*
	Alliances, partnerships and JVs with key stakeholders	*Proactivism*
	Regular and continuous participation	*Proactivism*
	Demonstration of performance	*Proactivism*
Market risk	*Use of contingencies and discount factors in budgeting and modelling*	*Conservatism*
Environmental compliance	*Obtain compliance requirements early*	*Due diligence*
	Budget for worst case scenario	*Conservatism*
	Develop relationship with consent authorities	*Proactivism*
	Understand obligations	*Proactivism*
	Use knowledge specialists	*Due diligence*
	Liaise with key stakeholders	*Proactivism*
Local content obligations	*Understand obligations early*	*Proactivirty*
	Budget for variation	*Proactivism*
	Develop relationship with consent authorities	*Due diligence*
	Understand obligations	*Due diligence*
	Use knowledge specialists	*Due diligence*
	Liaise with key stakeholders	*Proactivism*
Vandalism	*Early intervention*	*Proactivism*
	Ongoing consultation	*Proactivism*
	Community participation	*Proactivism*
	Encourage local stewardship	*Proactivism*
Political risk	*Understand the political environment*	*Due diligence*
	Develop relationships with key stakeholders	*Proactivism*
	Lobby and educate	*Proactivism*
Equipment failure	*Develop relationships with key suppliers*	*Due diligence*
	Plan for contractual obligations	*Proactivism*
	Eg warranty period, liquidated damages	
	Budget for worst case scenario	*Conservatism*

Source: Developed for this research

This table demonstrates the strategies adopted by developers to mitigate against specific risks identified. Further the table broadly classifies the risk management strategies into the three categories developed for this research, namely; proactivism, due diligence and conservatism.

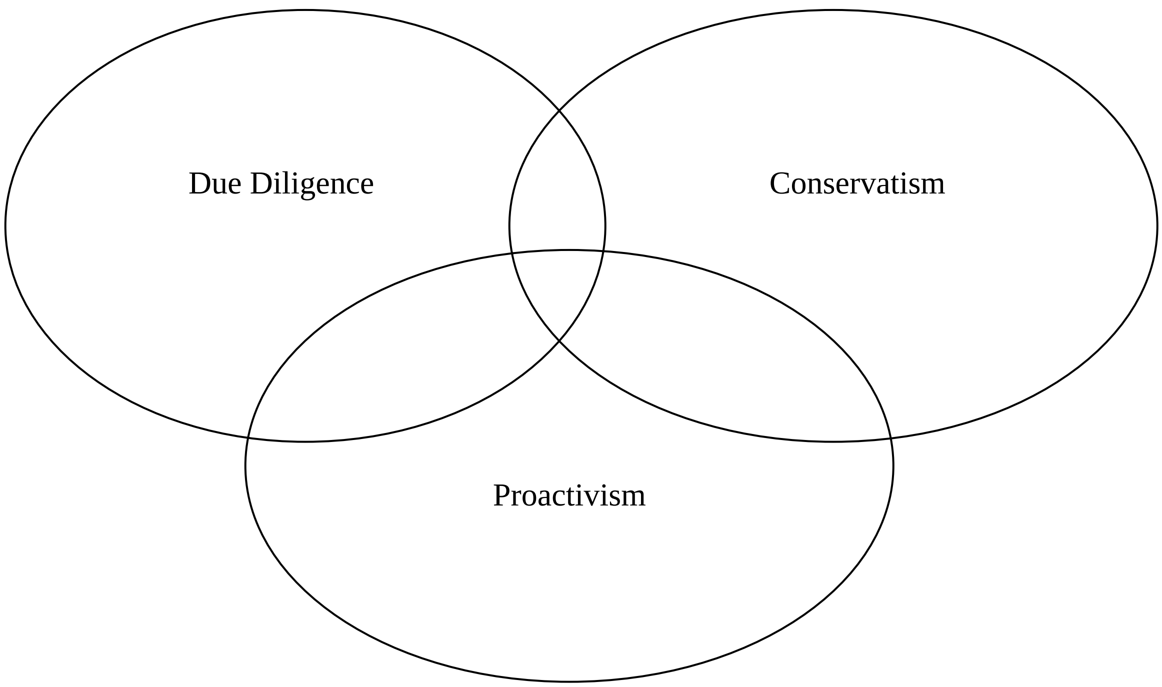
6.8 What type of risk management strategies are adopted by project developers?

Floricel and Miller (2001) developed a taxonomy of risk management strategies comprising:

- information/selection
- co-optation
- allocation
- design
- action

These five categories of strategies can be further simplified into the three types of strategies identified in this research to include due diligence, conservatism and proactivism.

Figure 6.1 A taxonomy of risk management strategies



Source: Developed for this research

The taxonomy of risk management strategies depicted in Figure 6.1 (above) seeks to categorise between the three main approaches of due diligence, conservatism and proactivism developed through this research. These relate to Floricel and Miller's (2001) taxonomy as shown in Table 6.4 (below).

Table 6.4 Integrating the taxonomies of risk management strategies

Due Diligence Undertaking the necessary information gathering, economic and project modelling, process modelling	**Information/selection**. Approaches used to gather information and shape the project concept	*Studies*: literature search, forecasts, surveys, tests, simulations, theoretical models, bureaucratic procedures *Private search*: use of personal contacts to obtain privileged information and aggressively shape a project opportunity *Relational probes*: meeting stakeholders and opponents to identify risks, eliminated unworkable options and enrich the project concept
Proactivism Actively pursuing methods for reducing risk by developing links with key stakeholders, contractors and suppliers	**Co-optation** Approaches used to obtain the required competencies and secure access to resources	*Outreach*: extent to which independent entities are brought in *Link*: the relation established between an owner and other co-opted entities *Hierarchical*: business units and subsidiaries *Partnership*: co-owner, joint-venture, equity investment *Contractual*: contracts and other formal agreements *Engagement*: informal agreements *Alignment*: extent of task grouping under the responsibility of one entity *Choice*: type of bidding and negotiation procedure, level of specification detail
Conservatism/Due Diligence Use of documentary mechanisms to protect parties and allocate responsibilities and risk.	**Allocation** Use of contractual clauses to apportion rewards, risks and responsibilities between participants	*Responsibility*: detailed delineation of the obligations of each party and the conditions under which these are performed *Price*: contract price determination formulae, including risk-sharing, penalties and incentives *Transfer*: clauses limiting the exposure of one party in case of negative events
Due Diligence Detailed application of information and project management processes	**Design** Use of project concept elements to reduce the likelihood and impacts of risks	*Technical*: inclusion of elements, overall architecture and specific solutions, performance levels *Organisational*: structure of supervision, reporting and information flows; co-ordination and conflict-resolution procedures and places *Schedule*: timing and sequence of activities *Financial*: type and timing of financial flows, payment conditions
Proactivism Actively pursuing framebreaking strategies to reduce risk	**Action** Use of actions to reduce the likelihood of opposition or remove obstacles to project development	*Confrontation*: aggressive tactics such as suing and organising protests *Persuasion*: communication strategy and education of stakeholders *Exchange*: payments or other benefits to individuals and communities to compensate for inconveniences and obtain support *Legitimation*: approaches and symbolic gestures that signify probity, fairness, care and respect

		Pre-emption: taking early steps in order to signal commitment and block eventual competition or opposition or to develop alternative avenues for action
Conservatism Use of worse case scenarios and sensitivities to reduce risk.		***Examples:*** *Breakeven analysis* *Contingencies* *Discount factors*

Source: Adapted from Floricel and Miller (2001)

This taxonomy demonstrates that the categories are not mutually exclusive and provide a range of strategies for developers to adopt to reduce the risks identified.

6.9 What are the future risks for the industry?

Through the research process, project participants were able to identify a range of risks that present potential threats to the industry. These included:

- government policy and legislation
- grid/resource constraints
- finance risk and interest rates
- environmental performance and compliance
- operations and maintenance
- community stakeholder management

6.10 How should these future risks be addressed?

A range of strategies were devised by developers to address the future risks identified. These are listed in Table 6.5 (below).

Table 6.5 Strategies to address future risks to wind energy developments

Future Risk	***Mitigation measure***	***Theme***	***Taxonomy***
Government policy and legislative impediments	*Lobbying government regulators to secure market mechanisms* *Need for government to take a longer term view* *Need to engage with politicians at every level using well known environmental champions and "in your face" campaigns like those used in the UK* *Need to lobby to increase MRET* *Need to use industry associations to lobby* *Direction for future investment needs to come from government* *Need to lobby and educate associated energy industries such as coal mining and nuclear on the benefits of wind* *Need for continuous(longer term) and consistent policy*	*Lobbying* *Policy* *Lobbying*	*Proactivism* *Proactivism* *Proactivism* *Lobbying* *Lobbying* *Policy* *Lobbying/Education*
Grid/Resource constraints	*Lobby to modify technical aspects of the electricity market to allow increasing amounts of wind penetration.*	*Lobbying*	*Proactivism*
Finance risk and interest rates	*Be certain of the offtake market and forward pricing forecasts.* *Ensure appropriate contingencies are allowed for especially wind speeds and capital costs*	*Economics* *Contingencies*	*Due Diligence* *Conservatism*
Environmental performance and compliance	*Need to push ahead with the better projects and hold off on less feasible projects*	*Economics*	*Conservatism*
Community stakeholder management	*Need for education for community acceptance* *Need to demonstrate environmental and economic sustainability*	*Education*	*Proactivism* *Proactivism*
Decommissioning/O&M	*Need to provide decommissioning funds for project removal and/or retrofitting*	*Economics*	*Due Diligence/ Conservatism*

Source: Developed for this research.

Table 6.5 lists the key future risks identified through the research, the potential mitigation measures, the key themes and risk categorisation. Each of the key themes of policy, lobbying, education, economics and demonstration are described in more detail.

Lobbying and policy

According to the developers the industry needs to lobby every level of government to ensure greater security and tenure of policy. In addition government regulators need to be lobbied to secure the market mechanisms such as MRET, and to allow greater wind penetration of the existing generation market as has occurred in other countries. In the case of the MRET this lobbying should be to increase the percentage of renewable generation and lengthen the timeframe beyond 2020. Further it is suggested that the wind industry should work with other associated and competitive industries such as coal and nuclear to encourage wind energy adoption alongside traditional and newer generation technologies.

Education

Closely aligned with lobbying and policy is the precursory theme of education. Participants suggested that educational campaigns such as the UK wind industry's "Embrace Wind" have been successful in generating community support for wind energy. This proactive community support has led to policy changes at a number of levels in the UK market.

Economics

Some participants described the need for economic expectations of projects to be more realistic based upon the existing market conditions. Whilst it is difficult to forecast future power prices, it seems reasonable to make a number of assumptions which would quickly reduce the viability of a number of projects around Australia due to marginal wind resources and limitations of grid capacity. This then allows for the introduction of contingency factors to offset the risk factors associated with such unknowns. Participants suggested that contingency factors should be allowed for power price, wind speed, capital cost and decommissioning.

Demonstration

One participating developer suggested that the industry needs to be able to demonstrate that the claims made by developers are true, and that the industry has a responsibility to demonstrate economic and environmental sustainability of the industry.

This section of the chapter has sought to answer the research questions and solve the research problem. The key risks have been identified, prioritised and potential mitigation measures suggested. The mitigation measures have then been classified and a more broad taxonomy of risk mitigation strategies developed. The next section will describe the implications of the research for theory, policy and practice.

6.11 Implications of the research for theory, policy and practice

This section of the conclusion will discuss the implications of the research project for theory, policy and practice of wind energy project development.

According to these research findings, for the wind energy industry to progress in Australia, this research has demonstrated the need for a change to the Mandatory Renewable Energy Target. At a national level the MRET needs to be increased from the current 2% renewable target and extended beyond 2020 for further projects to be developed. National legislation requires some significant changes to reflect a more progressive target such as those now being proposed by the US, EU and parts of Asia.

The Australian federal government through the AGO accepts that global warming is occurring and accepts that climate change is a significant risk. Further the AGO has accepted that emissions of carbon dioxide from coal fired power stations have been identified as one of the major causes of greenhouse gas emissions.

Renewable energy has the capacity to substitute traditional energy sources in a cost competitive way, without the need for greenhouse gas emissions. Thousands of megawatts of proposed renewable energy projects are developed to approval stage and are ready to commence, if the incentive existed for utilities to purchase the power from these proposed projects at a viable price.

The Australian Federal government also needs to provide more confidence to developers on the potential risks associated with federal approval processes. The recent cases of veto of wind energy projects by the federal minister for the environment has reduced the level of confidence of the ability of developers to progress some projects.

At a state level, several of the state governments have proposed renewable energy targets over and above those targets established at the federal level. The Victorian government, for example, is seeking to establish a 10% renewable energy target this calendar year (2006). To date, there has been resistance to such a move by some members of the fossil fuel industry, fearing that this will significantly increase the price of electricity to end users.

In the absence of a revised federal renewable target, and for the industry to progress, the state governments across Australia should seek to establish uniform development standards and consent guidelines for the development of a viable and sustainable wind energy industry.

At a local level, councils should either take full responsibility for development consent or defer to a single state government instrumentality for the approval process. The presence of streamlined local government approval processes needs to be concurrent with uniform guidelines for project assessment and development. Local councils should be requesting consistent types of information applicable to all wind energy projects to allow developers a stronger sense of confidence and security of the process and the relevant costs applicable to each development application.

Consistent mechanisms for environmental performance monitoring also need to be considered. Some of the obligations placed on project environmental performance provide uncertainty in the ongoing viability of projects. Risk mitigation methods such as turbine stoppage during particular environmental periods may reduce the potential economic viability of wind energy projects.

At the industry level, the Australian wind energy industry requires a greater level of political power to affect the necessary changes to state and federal legislation. At present the industry is losing active project developers and stakeholders to the growing overseas market. The industry has active lobby groups in AusWind and the Renewable Energy Generators Association which have had a limited effect on changing legislation to promote renewable energy. The industry needs to develop greater strength and lobby power through greater investment by existing players, recruitment of strong supportive community groups as well as through related industry players such as the more traditional energy companies. Recruitment of those significant companies seeking to differentiate themselves in the marketplace such as Shell and BP, would create strong allies and political partnerships to facilitate discussions with government on the amendment of policy to encourage renewable energy development.

Industry also needs to play a greater role in the education of the general community on the benefits of wind energy to the greater population. Whilst the emphasis is on reducing greenhouse gas emissions, more emphasis needs to be placed on the other benefits of wind energy such as regional manufacturing, employment and education. Accurate figures publishing actual figures of flora and fauna affected by wind energy projects needs to be released and compared to the impacts associated with other more traditional industries.

At the corporate level, the research indicates that most developers operate under a project management framework. The study also emphasises the need for companies to ensure the legitimacy of the proposed projects through thorough economic modelling and the use of correlation of reliable long term wind data.

The management of the identified risks will then vary depending upon the size and scope of the project, its location and the attitude of the company to particular risks. The research indicates that most companies undertake some form of formal or highly structured risk management process, often in accordance with the Australian Standard for Risk Management (AS/NZS 4360 2004). Little assessment however is considered for cumulative risks or internal company risks.

In the risk management process, the research demonstrates that wind energy development companies are adept in the identification and assessment of the many risks involved in the project management process. The research did not, however seek to further probe the types of risk management tools utilised by the project and risk management divisions to assist in the decision making process.

The issue of negative community concern toward wind energy is one which can be addressed through education. Wind energy technology is no longer a new industry, given that the windmill itself is an historical farm instrument traditionally used for pumping water and milling grain. Further, the use of turbines to generate energy has over 30 years of history in the US and Denmark in particular. Given these facts, many of the lessons associated with the negative impacts of wind turbines have already been determined with research and development working toward further reducing these impacts such as sound pressure levels.

Community education needs to occur at a variety of levels to address and dispel the myths and truisms associated with the technology. Key decision makers and policy directors need to be targeted with beneficial information. Also the media need to be better informed with respect to the types of information presented. Whilst the wind industry was flourishing in Australia in the early 2000s, the amount of *bad press* associated with wind energy projects was greater than the present situation, where the *bad press* is more inclined to be asking why Australia is not doing more about emission reduction and global warming.

This research has provided a more insightful risk register for wind energy projects in Australia. These risks have been categorised and their management divided into a new set of risk management taxonomies defined as due diligence, proactivism and conservatism. This provides project and risk managers with an improved set of tools to better manage the development of wind energy projects in Australia.

This research also provides educators of project and risk managers an insight into the more recent issues facing developers and projects, and may also assist in the improved management of development projects.

6.12 Limitations

Given that the research was primarily exploratory, and involved the use of case study methodologies, the findings have a limited ability to be generalised. Since only several projects were selected it is difficult to broaden the findings to encompass other wind farms in Australia or internationally.

6.13 Further research

This research project has the potential to be extended and expanded through quantification of data in other projects located around Australia, including both completed projects and incomplete projects. Also the research could include other types of renewable energy projects within Australia.

There is an opportunity to extend a number of the themes within this research project into other commercial areas. The types of potential research questions which have been identified in this research include:

- *Do developers of wind energy projects in Australia have any background or experience in project management? Are they familiar with the relevant risk management standards and processes?*
- *How do developers of wind energy projects in Australia estimate risk consequence and likelihood for their projects?*
- *What types of risk analysis do developers undertake and why (assumptions, methods, qualitative and/or quantitative, sensitivity analysis)? How is this undertaken (software, data, etc).*
- *What types of internal risks exist for wind energy projects in Australia? How are these identified assessed and managed?*
- *What are the cumulative impacts of risks for wind energy developments in Australia?*
- *What are the levels of community dissatisfaction with proposed wind energy projects in Australia?*
- *What levels of community support exist for development of nuclear power in comparison to wind energy and other renewable energy sources?*

- *What are the implications of global warming on the future viability of wind energy projects?*
- *What is the level of local community dissatisfaction with wind energy projects in Victoria?*
- *How can the renewable energy industry affect government policy to encourage further project development in Australia?*
- *What are the environmental impacts of wind energy projects in Australia, relative to other energy generators?*
- *What types of risk management tools are used by project managers within the wind energy industry?*

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8 APPENDICES

Appendix 1 - The case study protocol: List of contents
Source: Adapted from Yin (1994), Yin (1989), Carson et al. (2001).

Purpose

Key Features of the Case Study Method

Organisation of the Case Study Plan

Procedures

Initial Scheduling of Field Visit

- Review of Preliminary Information
- Verification of Access Procedures
- Special Documents
- Letter of Introduction

Determination of Persons to Be Interviewed and Other Sources of Information

- Projects
- Project Managers
- Project Management Function
- Risk Management Function
- Summary

The Case Study Data Base

Case Study Protocol and Questions

- Definition of the Project
- Topics
- Summary of Questions

Analysis Plan and Case Study Reports

Individual Case Studies

Descriptive Information

Explanatory Information

Outline of Individual Case Study Reports

Cross Case Analysis

Descriptive Information

Explanatory Information

Cross-Case Analysis Report

References for Case Study Plan

Appendix 2 - Preparation for data collection

Source: Adapted from Yin (1994), Yin (1989), Carson et al. (2001)

Overview of the Case Study Project

- Background Information
- Substantive Issues
- Project Statement
- Project Objectives/Purpose
- People Involved
- Letter of Introduction
- Case Study Issues
    - Project Selection
    - Participant Selection
- Relevant Readings

Field Procedures

- Credentials
- Access to the Case Study Sites
- General Sources of Information
- Procedural Reminders
- Data Collection Procedures
- Survey Design/Questionnaire
- Schedule of Data Collection
- Contingencies

Case Study Questions

- Reminder questions to the Researcher
- Questions to the Participant
- List of Probable Sources of Evidence

Appendix 3 - Cover letter for survey research instrument

Source: Adapted for this research

Richard Finlay-Jones
DBA Candidate
Southern Cross University
PO Box 9
Merewether
NSW 2291
P: 02 4934 7254
F: 02 4934 8604
M: 0414 555 864
E: finlayjones@ghg.com.au

Date

Dear Participant

Risk Management Survey Interview

Introduction

The purpose of this letter is to provide background information to the risk management interview and research in which you have been asked to participate. This survey is designed to provide an insight into the types and nature of the risks associated with the development of wind energy projects in Australia.

Purpose of the Research

The information obtained from the survey will be used as part of a Doctor of Business Administration thesis examining *risk management of wind energy projects in Australia*. This research will seek to develop a risk register for wind energy projects and provide some insight into the risk management procedures of wind energy project develpers in Australia.

Objectives of the Research

Wind energy development in Australia is perceived as offering some solutions to the development of renewable energy in Australia, and the industry is forecast to increase significantly in size over the next few years. This research will seek to reduce the risks associated with new project developments and assist developers to develop a viable and sustainable industry based on improved risk management techniques.

Selection for Participation

You and your organisation have been selected to participate in this research according to the criteria of *completion of commercial scale wind energy project(s) in Australia*. Very few organisations in Australia can attest to this level of experience in wind energy project development.

Informed Consent

Ethically, I am bound to inform you of the following:

a. Completing this interview is voluntary;
b. Total anonymity is assured, as your name is not required. In any event, complete confidentiality is assured. For case study analysis and research reporting, individual and organisational details will be disguised to ensure confidentiality and anonymity;
c. The information collected from this interview is provided solely for inclusion in a Doctor of Business Administration thesis.
d. There will be no harmful effects on any participants
e. It is my intention to maintain objectivity and integrity, and to conduct unbiased investigations of the responses contained in the interview, to support the research being undertaken.

My Involvement in the Wind Energy Industry

I must inform you that I am engaged by Energreen Wind Pty Ltd to develop potential wind energy projects in Australia. If this presents any problem for you or your organisation, I would be happy to discuss the matter with you.

Contacts

Should you require further information, or wish to discuss the research project in more detail, please feel free to contact me on the details below:

Richard Finlay-Jones

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Southern Cross University
PO Box 9
Merewether NSW 2291
P: 02 4934 7254
F: 02 4934 8604

M: 0414 555 864

E: finlayjones@ghg.com.au

Alternatively, my supervisor can be contacted at these locations:

Professor Alex Kouzmin
Graduate School of Management
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PO Box 157
Lismore NSW 2480
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F: 02 6626 9170
E: akouzmin@scu.edu.au

Thank you for your time and support with this activity which will provide a significant contribution toward my Doctorate of Business Administration degree.

Yours sincerely

Richard Finlay-Jones

Appendix 4 - Consent to participate in a research project

Project Title: ***Risk Management Issues in Wind Energy Developments in Australia*.**

Part A: For the participant to complete

I have read and understood the introductory letter regarding this research project. ☐

I am over the age of 18 years and would be pleased to be involved in the project. ☐

I agree to the researcher taking hand written notes during the interview. ☐

I wish to remain anonymous in any publication arising ☐

OR

I consent to being identified in any publication arising, on the understanding that I approve a final version of the material containing my name. ☐

I understand that all references in my interview to third parties will not be incorporated in published works unless the third party consents. ☐

Your name:…………………………………….

Your signature…………………………………. Date……………………

Name of witness……………………………………………………………

(independent from project)

Signature of witness……………………………..Date……………………

Date………………………………………………

Part B: For the researcher to complete

I certify that the terms of this research have been carefully explained to the participant by letter and follow-up discussion, and that the participant appears to have understood.

The participant has indicated the following restrictions are placed on any data generated during the research (note if none apply):
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
……………………………………………………………………………………

Name of researcher:………………………………………………………..

Signature of researcher:…………………………Date:…..........................

Appendix 5 - Interview Guide

Source: Adapted for this research

Thesis Topic:

Risk management issues in the development of wind energy projects in Australia

Introduction

Thank you for taking the time to participate in this research.

Purpose of the Research

The information obtained from the survey will be used as part of a Doctor of Business Administration thesis examining *risk management of wind energy projects in Australia*. This research will seek to develop a risk register for wind energy projects and provide some insight into the risk management procedures of wind energy projects in Australia.

Objectives of the Research

Wind energy development in Australia is perceived as offering some solutions to the development of renewable energy in Australia, and the industry is forecast to increase significantly in size over the next few years. This research will seek to reduce the risks associated with new project developments and assist developers to develop a viable and sustainable industry based on improved risk management techniques.

Informed Consent

Ethically, I am bound to inform you of the following:

- Completing this survey is voluntary;
- Total anonymity is assured, as your name is not required. In any event, complete confidentiality is assured. For case study analysis and research reporting, individual and organisational details will be disguised to ensure confidentiality and anonymity;

- The information collected from this interview is provided solely for inclusion in a Doctor of Business Administration thesis.
- There will be no harmful effects on any participants
- It is my intention to maintain objectivity and integrity, and to conduct unbiased investigations of the responses contained in the interview, to support the research being undertaken.

This interviewer’s guide is not a questionnaire but provides a framework for the interview.

Date:
Time Commenced:
Name of Organisation:
Name of Participant:
Position:
Name of Case Study Project:
The aim of this research is to investigate the nature of the risks in the development of wind energy projects in Australia.

Part One: Risk Types

Question 1:
I would like to begin the interview by asking you to share your experiences of managing the risks within the development of this wind energy project.

Prompts:
What were the main risks encountered during this project development?
How were these risks managed by the organisation?

Question 2:

Listed below are some of the major risks associated with wind energy project development. In the last column please rate on a scale of very low to very high, the level of risk associated with the project.

Risk Factor	**Subcategory**	**Risk Classification**
Prospecting	*Land assessment*	*Very low, low, moderate, high, very high*
Land Security	*Land Lease Option*	*Very low, low, moderate, high, very high*
	Land Lease	*Very low, low, moderate, high, very high*
Wind Resource	*Monitoring/modelling*	*Very low, low, moderate, high, very high*
Feasibility Studies	*Economic modelling*	*Very low, low, moderate, high, very high*
Development Application	*Environmental Impact Assessment*	*Very low, low, moderate, high, very high*
Licensing/Permitting	*Approvals and Licencing*	*Very low, low, moderate, high, very high*
Grid Connection	*Grid Connection Agreement*	*Very low, low, moderate, high, very high*
Power Purchase	*Power Purchase Agreement*	*Very low, low, moderate, high, very high*
Finance	*Debt*	*Very low, low, moderate, high, very high*
	Equity	*Very low, low, moderate, high, very high*
Construction	*Construction Agreement*	*Very low, low, moderate, high, very high*
	Construction Operations	*Very low, low, moderate, high, very high*
Operation & Maintenance	*O&M Agreement*	*Very low, low, moderate, high, very high*
	Operations and Management	*Very low, low, moderate, high, very high*

Question 3:

Can you think of other risks not listed or categorised that were important in this project development?

Part 2: Risk Management

Question1:
Can you describe the approaches taken by your organisation to reduce the risks associated with wind energy projects?

Question 2:
Listed below are the major risks associated with wind energy project development. In the last column please rate on a scale of none to highly structured, the type of risk management strategy associated with the project.

Risk Factor	**Subcategory**	**Risk Management Strategy**
Prospecting	*Land assessment*	*None, informal, formal, highly structured*
Land Security	*Land Lease Option*	*None, informal, formal, highly structured*
	Land Lease	*None, informal, formal, highly structured*
Wind Resource	*Monitoring/modelling*	*None, informal, formal, highly structured*
Feasibility Studies	*Economic modelling*	*None, informal, formal, highly structured*
Development Application	*Environmental Impact Assessment*	*None, informal, formal, highly structured*
Licensing/Permitting	*Approvals and Licencing*	*None, informal, formal, highly structured*
Grid Connection	*Grid Connection Agreement*	*None, informal, formal, highly structured*
Power Purchase	*Power Purchase Agreement*	*None, informal, formal, highly structured*
Finance	*Debt*	*None, informal, formal, highly structured*
	Equity	*None, informal, formal, highly structured*
Construction	*Construction Agreement*	*None, informal, formal, highly structured*
	Construction operations	*None, informal, formal, highly structured*
Operation & Maintenance	*O&M Agreement*	*None, informal, formal, highly structured*
	Operations and Management	*None, informal, formal, highly structured*

Question 3: Future Risks

What do you think are the major risks facing the wind energy industry in the future?

Question 4:

How should we be addressing these risks to increase the chance of project success?

Thank you for your assistance with this research project.