VAASAN YLIOPISTO

TOMI MÄKIPELTO

The Competitive Priorities Affecting Energy Production Investments

Wind Power in Finland as a Special Issue

ACTA WASAENSIA NO 231

INDUSTRIAL MANAGEMENT 20

UNIVERSITAS WASAENSIS 2010

Reviewers

Professor Tuomo Kässi
Lappeenranta University of Technology
Department of Industrial Management
P.O. Box 20
FI–53851 LAPPEENRANTA
Finland

Professor Harri Haapasalo
University of Oulu
Department of Industrial Engineering and Management
P.O. Box 4610
FI–90014 UNIVERSITY OF OULU
Finland

Julkaisija	**Julkaisupäivämäärä**	
Vaasan yliopisto	Joulukuu 2010	
Tekijä(t) Tomi Mäkipelto	**Julkaisun tyyppi** Artikkelikokoelma	
	Julkaisusarjan nimi, osan numero Acta Wasaensia, 231	
Yhteystiedot Vaasan yliopisto Teknillinen tiedekunta Tuotantotalouden yksikkö PL 700 65101 Vaasa	**ISBN** 978–952–476–321–9	
	ISSN 0355–2667, 1456–3738	
	Sivumäärä 154	**Kieli** Englanti

Julkaisun nimike

Energiatuotantoinvestointiin vaikuttavat kilpailutekijät – erityisaiheena tuulivoima Suomessa

Tiivistelmä

Tutkimuksessa tarkastellaan energiatuotantoinvestointiin vaikuttavia kilpailutekijöitä ja tuulivoimaan liittyvää problematiikka Suomessa. Vaikka energia-ala on kansainvälinen maailmanlaajuisien laitteisto- ja polttoainemarkkinoiden vuoksi, on se toisaalta alueellinen lainsäädännön ja lopputuotteiden rajallisen siirrettävyyden vuoksi. Koska tutkimuksessa keskitytään tarkastelemaan pääsääntöisesti yhteispohjoismaisilla sähkömarkkinoilla toimivaa Suomen energiatuotantojärjestelmää, voidaan alueellista lainsäädäntöä, ympäröivää yhteiskuntaa ja lopputuotteen kysyntää määrittävät tekijät huomioida.

Väitöskirjassa tutkitaan makrotasolla, strategisen johtamisen näkökulmasta, miten ja mitkä tekijät vaikuttavat energia-alan investoijien päätöksentekoon. Tutkimuksessa luodaan uutta tieteellistä tietoa alan tutkijoille, päättäjille, lainsäätäjille, investoijille ja laitevalmistajille.

Tutkimuskysymykset koskien yleisesti energia-alaa ovat seuraavat: millä tekijöillä on suurin vaikutus suuren mittakaavan energiatuotantoinvestointien elinkaarituottoihin ja miten ketterän strategisen johtamisen teorioita voidaan yhdistää energiatuotannon investointipäätösten kilpailutekijöihin? Tuulivoimaa koskien tarkastellaan, mitkä ovat investointiin vaikuttavat pääkilpailutekijät investoijan ja laitetoimittajan näkökulmasta ja millainen on investointihankkeen hyväksyttävyyteen vaikuttavien viitekehystekijöiden suhde muihin investointiedellytyksiin vaikuttaviin päätöstekijöihin.

Tutkimuskysymyksiin vastataan viiden artikkelin avulla. Tutkimuksen metodologinen viitekehys rakentuu usean erillisen tutkimusmenetelmän ympärille. Tutkimus osoittaa, että taloudellisilla ja poliittisilla tekijöillä on suurin vaikutus päätettäessä suuren mittakaavan energiatuotantoinvestoinneista. Ketterän strategisen johtamisen teorioita voidaan yhdistää energiatuotannon investointipäätösten kilpailutekijöihin. Tuulivoimaa koskien löydettiin kuusi erillistä kilpailutekijää, jotka vaikuttavat eniten investoijien ja laitetoimittajien välisiin näkemyksiin. Tuulivoimahankkeiden toteutuksesta päätettäessä on kolmen tekijän oltava oikeassa suhteessa toisiinsa: hankkeen hyväksyttävyyden, taloudellisuuden ja käytettävän teknologian.

Asiasanat

monikriteerinen päätöksenteko, strateginen johtaminen, energiatuotanto, tuulivoima

Publisher	Date of publication	
Vaasan yliopisto	December 2010	
Author(s) Tomi Mäkipelto	**Type of publication** Selection of articles	
	Name and number of series Acta Wasaensia, 231	
Contact information University of Vaasa Faculty of Technology Department of Production P.O. Box 700 FI–65101 Vaasa Finland	**ISBN** 978–952–476–321–9	
	ISSN 0355–2667, 1456–3738	
	Number of pages 154	**Language** English

Title of publication

The Competitive Priorities Affecting Energy Production Investments – Wind Power in Finland as a Special Issue

Abstract

This research investigates the competitive priorities affecting energy production investments and the special issues related to wind power in Finland. Even though the energy industry is global due to the global equipment and fuel markets, it is also local due to legislation and the limited transmittability of the end products. Since the research is primarily focused on the Finnish energy production system that is part of the Nordic electricity market, it enables the examination of factors that have an impact on local legislation, the surrounding society and the demand for the end product.

The dissertation is a macro-level study carried out from the perspective of strategic management. It investigates the factors affecting energy investors' decision-making processes and produces new scientific information for researchers in the field, decision-makers, legislators, investors and equipment manufacturers.

The research questions that concern the energy industry in general are the following: what kinds of factors have the largest impact on the life-cycle profits of large-scale energy production investments, and how can the theories of agile strategic management be combined with the competitive priorities affecting energy production investment decisions? As for wind power, the purpose of the research is to find out what the major competitive priorities affecting investments are from the investors' and suppliers' point of view, and what kind of relation the framework factors affecting the acceptability of investment projects have to the other decision-making factors affecting the investment preconditions.

The research questions are answered with the help of five articles. The methodological framework of the research is based on several different research methods. The research suggests that economic and political factors have the largest impact when making decisions on large-scale energy production investments. Further, the theories of agile strategic management can be combined with the competitive priorities affecting energy production investment decisions. Regarding wind power, six different competitive priorities were identified, in relation to which investors' and equipment suppliers' views differ the most. When decisions are made concerning the implementation of a wind power project, there are three factors that must be correctly balanced: the acceptability of the project, economy and the technology used.

Keywords

multicriteria decision-making, strategic management, energy production, wind power

ACKNOWLEDGEMENTS

Preparing the dissertation was very interesting. The greatest pleasure in doing academic work was the possibility to investigate my objects of interest from a scientific perspective. The detailed action plan that was drawn up at the beginning of the process helped in staying in schedule, and also made it possible to combine employment, dissertation work and free time.

First of all, I express my warmest thanks to my supervisor Professor Josu Takala. His support at different stages of the work has been essential. The dissertation was mostly written during weekends, and Professor Takala’s mind-refreshing messages brightened the sometimes tiring writing process.

During the work, I have had to shed some sweat, above all during the final stages of the work. However, I managed to turn the difficulties encountered into victories, which is attested by this dissertation becoming completed.

I would like to express my thanks to the persons who have participated and put their time in this project. Many thanks go to close friends and colleagues who helped and supported me during the preparation of the dissertation.

I would also like to thank Professor Tuomo Kässi and Professor Harri Haapasalo for reviewing the dissertation. In addition, I would like to thank the experts who have contributed to this study for using their time for scientific research.

Finally, I would like to express special thanks to Sanna and my family for understanding my prioritising my time and the great support, which helped me to complete this study.

Only those things can be achieved that one wants. A search for new challenges begins!

Vaasa, December 2010

Tomi Mäkipelto

Contents

Figures

Tables

Formulas

Abbreviations

AHP	Analytic hierarchy process
CO_2	Carbon dioxide
ETS	Emissions trading scheme
EU-27	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom
GDP	Gross domestic product
IMPL	Implementation index
ICR or IR	Inconsistency ratio
MW	Megawatt (1 MW = 10^3 kilowatts**)**
RAL	Responsiveness, agility and leanness model
TWh	Terawatt hour (1 TWh = 10^3 megawatt hours = 10^6 kilowatt hours)

ARTICLES

1 INTRODUCTION

The energy industry is experiencing a constant change. Global energy consumption is increasing, which, with the current technology, will also increase CO2 emissions into the atmosphere. In the future, more effective energy use and different energy production technologies and forms will make it possible to reduce CO2 emissions per unit of energy gained. Increasing the use of electricity may provide one way to make the use of primary energy more efficient.

In December 2008, the European Parliament and the European Council adopted a comprehensive “20-20-20” package concerning the climate change. According to it, the EU countries commit to reducing greenhouse gas emissions by 20% by the year 2020, increasing the share of renewable energy sources to 20% by 2020 (compared to the 8.5% share in 2005) and improving energy efficiency by 20% by 2020. The energy and climate package also includes a target to reach a 10% share of renewable energy in the transport sector by the year 2020. It also contains an additional obligation to raise the overall emission reduction target from the current 20% to 30% in case a global climate change agreement is reached (COM, 2007a).

The EU’s new energy policy will bring significant changes to its energy system, and achieving the targets will necessitate strong regulatory measures, such as new energy subsidies or taxes, simplified permission practices and education.

In November 2008, the European Commission proposed an action plan concerning energy security and energy sector solidarity in the EU. The objectives of the action plan are sustainable development, competitiveness and above all security of energy supply. The plan reflects an idea that a competitive energy market as well as a long-term energy and climate policy are essential in order for the 20-20-20 targets and a stable investment environment to be achieved.

The EU targets are challenging compared to the situation in the USA, China, India and the world in general. Table 1 shows the population, gross domestic product (GDP), energy use, electricity consumption and CO2 emissions of these countries in 2005.

Table 1. GDP- and energy-related key figures from China, India, USA, Finland, EU and the world.

	2005	China	India	USA	Finland	EU	World
Population	Mil.	1,304	1,097	0,296	0,005	0,490	6,515
GDP	USD 1 000 Mil.	2,236	0,784	12,422	0,196	13,776	44,747
GDP / Population	USD	1,715	0,715	41,981	37,299	28,100	6,869
Energy use	kg of oil equiv. per cap.	1,316	0,491	7,893	6,664	3,681	1,796
Electricity consumption	kWh per capita	1,781	0,480	13,648	16,120	5,498	2,678
CO_2 emissions	kg per capita	3,900	1,100	19,500	10,500	8,100	4,200
GDP/Energy use	USD per kg of oil equiv.	1.3	1.5	5.3	5.6	7.6	3.8
GDP/Electricity con.	USD per kWh	1.0	1.5	3.1	2.3	5.1	2.6
GDP/CO2 emissions	USD per kg	0.4	0.6	2.2	3.6	3.5	1.6
CO2 emissions/Energy use	kg per kg of oil equiv.	3.0	2.2	2.5	1.6	2.2	2.3

Source: STAT, 2009

The key values in Table 1 indicate that the energy consumption and CO2 emissions per citizen are significantly smaller in India and China than in the EU and the USA. However, the consumption of one unit of energy in China produces twice the amount of emissions compared to Finland. The consumption of energy is more environmentally friendly in the EU than in the world on average.

From the point of view of GDP, there are noticeable differences between the countries. The amount of GDP per one unit of energy, or of emission, generated by the citizens of the USA and EU is significantly greater compared to China, India or the global average. Nevertheless, the consumption of energy and amount of emissions per person are significantly smaller in India and China.

As for CO2 emissions, China, the USA, India and the EU produced approximately 60% of the global CO2 emissions in 2005. In their study, experts of the PricewaterhouseCoopers (2009) company have calculated that the share of China, the USA, India and the EU in producing CO2 emissions will increase to 63% by the year 2050.

The constant increase in the consumption of electric energy and the existing electricity production capacity becoming outmoded will create a growing need to invest in new energy production forms in the future. According to Shell (2009) *energy scenarios to 2050*, between the years 2010 and 2030, the greatest pressure for growth will concern electric energy produced by coal and wind. When this scenario assessment is extended to the year 2050, the third important factor will be electricity generated by solar energy. On the whole, Shell (2009) anticipates that the global consumption of electricity will more than triple between 2000 and 2050 (Shell, 2009).

According to VTT's (2009) publication *Energy Visions 2050*, the driving forces affecting the development of the energy industry can be divided into four different areas: economic growth and population, dynamics of technology development, improvement of energy security and response to climate change and other environmental impacts. Looking at these factors, it is clear that the investment pressures related to energy production are influenced by many different drivers. In addition to the drivers mentioned, new investments in the existing production capacity also create needs for investments in the energy production capacity.

In any case, the scenario examination suggests that the consumption of electric energy is anticipated to continue growing. This will affect energy production through both the construction of new power plants and the replacement of existing ones. Moreover, the capital-intensive investments characteristic of the energy industry will create possibilities for equipment suppliers and investors operating in the industry.

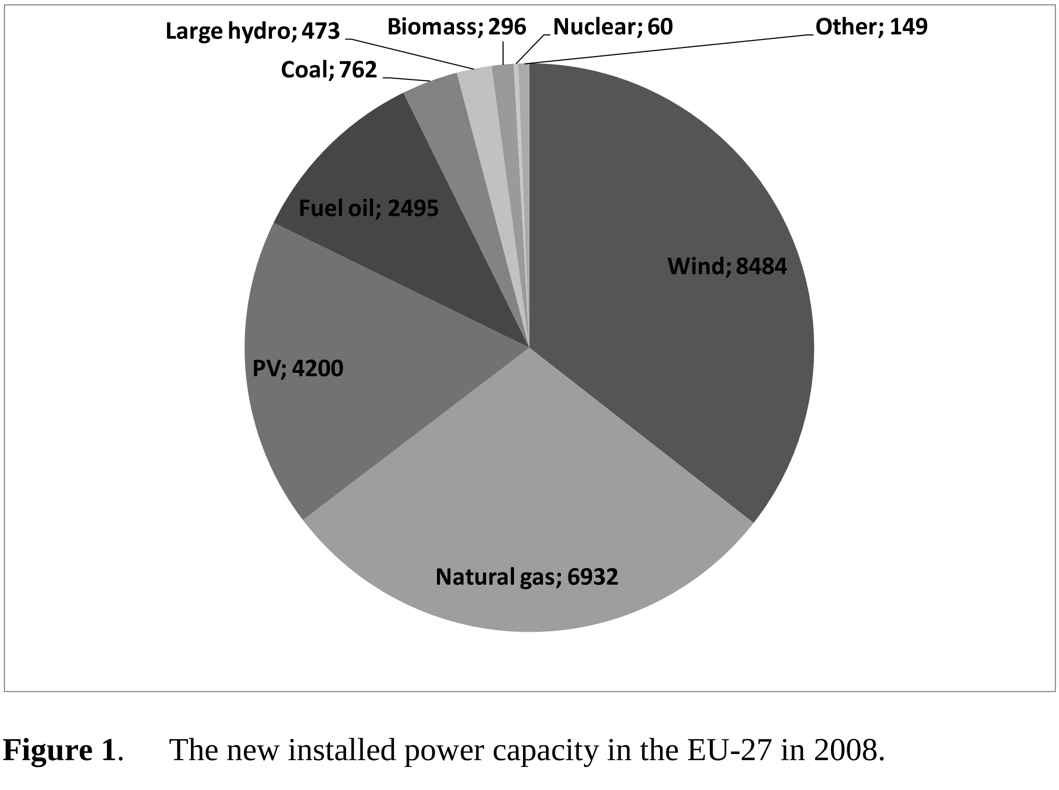


Figure 1. The new installed power capacity in the EU-27 in 2008.

Source: EWEA, 2009

In 2008, the total amount of new energy production capacity installed in the EU-27 area was 23,581 MW (EWEA, 2009). Examined from the point of view of output capacity, investments in wind power made 35.8% of this amount (see Figure 1). However, examined from the point of view of energy production, the share of wind power was smaller due to the changes in the EU-level energy production capacity portfolio.

1.1 Background

This dissertation has been created by combining scientific research with practical work in a company operating in the energy industry. This has enabled the researcher to produce new scientific information with a close view to the industry. While carrying out the study, the researcher has become thoroughly acquainted with the field of research in question and acquired an ability to use scientific research methods independently and critically in this field. The examination of the object of research through various frameworks has deepened the study and also enabled its critical evaluation.

While carrying out the study, the researcher has thoroughly explored scientific, economic and technological areas related to his field of research, as well as their research and planning methods. He has also carefully examined the development, societal significance, environmental effects and theory of science of these areas, as required by the nature of his field of research.

The new information produced by this research is valuable for it provides a scientific basis for the evaluation of the success factors related to energy production projects as well as for the assessment of the current, diverse scientific and political discussions on the energy industry. The research shows that the energy industry is complex due to the capital-intensive investments with long payback times and that the changing operating environment and the various regulatory methods it gives rise to create a situation for the operators in the industry in which there is a risk of generating generally unoptimal solutions through partial optimisations.

The researcher acts as director in charge of strategic development in an energy company operating in the Nordic electricity market and as managing director of several wind power companies. His employment background has enabled him to utilise strong empirical knowledge for scientific purposes.

The energy sector is under change. It is very likely that the operating methods of the energy sector and forms of energy production will be regulated through different means in the future due to the target of controlling climate change and long-term availability of energy. This, moreover, will have far-reaching effects because different kinds of regulatory means that are in contrast to normal market economy conditions cause partial optimisation, as a result of which the overall competitiveness of the industry may suffer. The pressures for change for the energy industry are great, which renders this type of research all the more important.

Preparing regulatory measures for the energy industry differs from preparing them for another type of industry owing to the long payback times of investments and political framework factors that have an influence on the energy sector.

On the other hand, if the complex nature of the energy industry and the possibilities it generates are examined from the point of view of equipment and technology suppliers, the possibilities appear significant. The capital-intensive investments in the energy industry create a great demand potential for different kinds of products and production plants. Equipment and technology suppliers are dependent on the local regulatory measures concerning the energy sector in each market. They have, however, the possibility to sell their products worldwide and thus disperse the restrictions and technological risks related to the use of the products. Considering the question of practical relevance, the factors introduced in this section support the importance of this research.

1.2 Previous Research and Research Gaps

From the point of view of strategic management, the investment decisions in the energy industry are affected by many factors both internal and external to the companies. From the perspective of energy sector decision-makers, identifying strategic issues that emerge and anticipating actions accordingly are an essential part of decision-making in the industry. Strategic issues refer to special issues arising from outside of the strategic process of a company, which significantly affect the company’s future competitive advantage or justification of existence. The systematic control of emerging strategic issues in a swiftly changing industry and from the point of view of large companies has been studied by Kunnas (2009) in his dissertation. The dissertation at hand contributes to and deepens this research by examining the problems related specifically to the energy industry, in which the operating environment of capital-intensive investments is influenced by sometimes rapid and difficult-to-predict definitions of policies and related regulatory measures.

The energy industry is at the centre of focus. In one way or another, factors related to the energy sector have an effect on the everyday lives of people, and thus they arouse interest in many spheres of life. Energy issues cause debates in politics, business life and even in families.

Studies concerning energy production create a basis for future investments. Therefore, it is important to investigate the preconditions and means of future energy production investments. Electric energy is produced by different forms. In this research, the forms of electric energy production are examined by focusing specifically on the problems and possibilities related to wind power.

The implementation of energy production investments is affected by an entire field of background factors related to management, technology and the surrounding society, which should be taken into account sufficiently so that investments can be implemented. The influence of institutions, technology and markets on the evolution of an industry has been studied for example by Moilanen (2009). In his dissertation, he has demonstrated that political decisions have both direct and secondary effects on the structures of industries as well as on the success and survival of companies. Public decision-making has far-reaching effects on an industry as a whole as well as on individual companies. Significant changes that arise from outside an industry alter the normal competition-based development of the industry and the intended effects of earlier public regulations and political decisions. Research results show that the energy industry is particularly affected by strong political and legislative regulatory measures. Thus, this dissertation will concentrate on the background factors related to implementing electric energy production in general and those related to implementing wind power investments in particular. The point of view is strategic, and the focus is on the Finnish conditions. The political and legislative frameworks of different countries have a strong controlling effect on the energy industry, and therefore the decisions made in each country should be adapted to the local investment framework.

The energy industry has been widely studied worldwide. Many organisations and institutions publish future scenarios related to the energy industry (see VTT, 2009; Shell, 2009). In these scenarios, the energy industry is examined as a whole, and the examinations are used to evaluate future energy production needs and development trends. VTT’s (2009) report investigates different energy production modes more thoroughly and evaluates their future operational preconditions.

In the future, the energy industry will face great challenges related to, for example, the climate change (IPCC, 2007), availability of fuels, general acceptability issues, the competitiveness between countries and continents and security of supply. It is likely that in the future the consumption of electric energy will make a significant part of the overall consumption of energy. This will have a direct influence on the production of energy because electricity systems must always be balanced as to the production and consumption of electric energy – at the same time taking into account the development possibilities enabled by technology, for instance in battery technology.

Energy production that would be optimal from the perspective of climate issues and the carbon dioxide content of the atmosphere has been studied by, among others, Bosetti et al. (2007). The study provides a basis for finding cost-effective strategies with which to achieve solutions optimal with respect to the climate objectives.

In technical sense, considering the operation of energy production plants (e.g. wind power plants or hydroelectric power plants) energy production is uniform throughout the world. Local differences in electric energy production are caused by the limitations of the transmittability of the end product. Consequently, local factors related to energy production, such as the availability of fuels, the technical state of the electricity system and the acceptability of energy production, have a direct impact on the construction of different forms of energy production and subsequently on the operational preconditions of energy production. The performance of local electricity markets or other similar energy production optimisation systems also has an effect on how energy is produced in the area in question at a certain time. In his dissertation, Jylhä (2006) has studied the development of electricity markets from the supply of electricity to the existence of electricity markets specifically from the Finnish point of view.

Steinbuks et al. (2009), on the other hand, have studied the effect of the price of energy on the operating methods and investment preconditions of companies in 23 OECD countries and four sectors (agriculture, commerce, manufacturing and transport) between 1990 and 2005. According to the study, the consumption of energy decreases as energy costs increase.

The societal effects of renewable energy production have been investigated for example by Bergmann et al. (2006). The research includes a set of values, which can be used to evaluate the social optimality of investments. Moran and Sherrington (2007) have further examined some of the results of this research in their study, which consists of a cost-benefit analysis used to assess the economic feasibility of a large-scale windfarm project, taking into account positive and negative externalities of generation. Lewis and Wiser (2007), on the other hand, have studied renewable energy and especially the support systems for wind power from a global point of view. In their research, they analysed the significance of the domestic market in the globalisation of technology companies. The studies above examine renewable energy and wind power from the perspective of the society. In this dissertation, however, these issues are studied from the point of view of investors, equipment suppliers and local decision-makers or legislators.

Blanco and Rodrigues (2008) have explained how the future Emissions Trading Scheme (ETS) legislation should be designed to allow the European Union to comply with the 20% greenhouse gas emissions reduction target, while at the same time promoting wind energy investments. They have found out that climate policy is unlikely to provide sufficient incentives to promote wind power, and that other policies should be used to internalise the societal benefits that accrue from deploying technology.

Local electricity networks are entities in which energy is generated primarily through the use of several different energy production forms. This enables the optimisation of larger entities. For example, with nuclear power it is possible to produce electric energy continuously. A nuclear plant is a baseload power plant. In contrast, with wind power energy is produced according to the wind conditions. Milligan et al. (2009) have investigated the challenges and cost effects related to the integration of wind power into an electricity system. The research suggests that new technological solutions (e.g. intelligent electricity networks) will further lower the costs of wind power integration in the future. Strbac et al. (2007) have studied the effects and possible constraints of wind power in the UK electricity system. According to the study, the system will be able to accommodate significant increases in wind power generation with relatively small increases in the overall costs of supply, about 5% of the current domestic electricity price in case of 20% of energy being produced by wind power in the UK. Meibom et al. (2007), on the other hand, have examined the benefits generated by wind power integration in relation to the production of district heating.

By the end of 2008, 120,791 MW of wind power had been installed worldwide, out of which 54% was in the EU-27 area (EWEA, 2009). Wind power production is not evenly distributed. For instance in Finland, the amount of wind power per surface area is relatively small (0.4 MW/km_2) compared to the European level (EU-27 average 14.0 MW/km^2) (EWEA, 2009). Söder et al. (2007) have collected experience from wind integration in some high penetration areas. Lu et al. (2009), on the other hand, have studied the global potential for wind-generated electricity. The focus of this dissertation is on Finland, where wind power is still a relatively new concept.

The special technical issues related to wind power can, in principle, be considered universal. In technical sense, there is country-specific variation to be taken into account in research, which is caused by local weather conditions (temperature, windiness and humidity) and the state of the electricity system. When climate conditions change, the effects of the local environment on the wind power plants also change. These changes have been studied by for example Laakso et al. (2006). In her dissertation, Holttinen (2004) has investigated the Finnish electricity system and the impacts of wind power on the system. On a general level, the effects of wind power on the electricity system have been examined by, among others, Holttinen (2008) and Söder and Holttinen (2008). Redlinger et al. (2002) have studied wind power potential, the profitability of wind power and the political trends in different countries.

Blanco (2009) has investigated the costs and the consequent construction preconditions of wind power from an economic perspective. The research suggests that the construction costs of wind power have increased by more than 20% in the three years preceding the research. Blanco’s (2009) research includes a detailed analysis of the share of costs of different wind power plant components. In this dissertation, the issues related to wind power construction are examined on a more general level, as a part of a greater whole, compared to Blanco’s (2009) research.

The acceptability of wind power from the point of view of environment has been studied in many ways. The effects of wind power on landscape, land use and flora and fauna have been investigated for example by Gipe (1995). These impacts have also been studied through different methods. For example, the economic value of the visual impact of wind turbines has been evaluated by Hanley and Nevin (1999) and Álvarez-Farizo and Hanley (2002).

Varho (2007) has investigated the future possibilities and political regulatory measures concerning wind power in her dissertation. In the study, she examined the societal factors that have had an impact on the slow development of wind power in Finland. The study concentrated on the views of Finnish national-level wind power operators. Such operators influence the development of the wind power sector and include for example civil servants, Members of Parliament, representatives of electricity production companies, the wind power industry and various organisations as well as wind power researchers. The results of the study showed that the views on wind power, its future and the regulatory means that should be used to promote it are sharply divided. This dissertation focuses in more detail on the factors that affect investment decisions related to the energy industry and specifically wind power. In general, setting in motion energy production and wind power construction in particular necessitates economic profitability, technical feasibility and especially acceptance gained from the surrounding society.

Lee et al. (2009) have studied investment-related decision-making in the wind power industry from a strategic perspective. The study sheds light on the critical success factors of wind power investments in China, analysing the related benefits, opportunities, costs and risks. The study contains a model based on the Analytic Hierarchy Process (AHP), which can be used to assess potential wind power projects and choose the optimal one based on the criteria. This dissertation is linked with the study of Lee et al. (2009) since the data it produces create a basis, which is further developed from macro to micro level in the scientific article written by Lee et al. (2009). Thus, this dissertation is connected to the scientific discussion in the field.

Factors related to this field of research have been successfully analysed in the earlier studies. Their results are primarily related to a certain discipline, which is why such interdisciplinary studies as this dissertation are important. The studies in this field of research have focused on, for example, technological, economic or societal analysis. The purpose of this dissertation, however, is to produce a comprehensive examination of the field, perceiving separate thematic entities in the background of the issues studied. Existing scientific knowledge is deepened through an investigation of local characteristics of energy production, by focusing on the Finnish energy industry. This has enabled the interdisciplinary study and production of new information for the use of the scientific community.

1.3 Objectives of the Dissertation and Research Questions

The objective of this research is to produce new scientific information concerning the factors that have the greatest impact on investment decisions in the energy industry. Anticipating and dealing with strategic issues is one of the most important areas of business strategy. Through well-timed strategic changes, the management of a company, community or nation may be able to create a competitive advantage in relation to others. The data produced by this research will be important to the scientific community, legislators, political policy-makers, energy investors, energy equipment suppliers, sponsors and other service providers. It is essential to understand that certain conditions must be met in order for the operators in the energy sector to be able to engage profitably in decades-long capital-intensive energy production plant projects.

The policy definitions made by the framework group that determines the future development of energy production are far-reaching. Typically, when plans for an investment in an energy production plant are started, it will take years, sometimes a decade, before the plant will start to produce energy. Therefore, it is important that the interest groups that shape the related framework use scientific data and recognise the complex issues related to energy production. As an example, the policies concerning climate change will have a significant impact on both climate-related and inter-country competitive advantage (cf. COM, 2007a; COM, 2007b; Finnish Government, 2008).

The research questions are specifically focused on the factors affecting the competitive priorities related to energy production investments. Some of the research questions have also been internationally tested, and they are divided into two parts: those that concern the energy industry in general and those that concern wind power as a special topic. The research questions concerning the energy industry in general are the following:

1. What kinds of factors have the largest impact on the life-cycle profits of large-scale energy production investments?
2. How can the theories of agile strategic management be combined with the competitive priorities affecting energy production investment decisions?

The following research questions concern wind power as a special topic:

3. What are the differences of the major factors of decision-making processes affecting investments from the investors' and suppliers' point of view?
4. What kind of relation do the framework factors affecting the acceptability of investment projects have to the other decision-making factors affecting the investment preconditions?

The research is focused specifically on Finland because each separate legislative framework constitutes an individual entity to be examined. Finland, Sweden, Norway and Denmark form a shared Nordic electricity market. In the Nordic electricity market, the market price of electricity is determined by the Nordic Power Exchange. However, each country constitutes a separate entity due to country-specific regulatory measures. These measures include for example national tax and support systems.

In addition to examining energy production in general, this research also investigates wind power as a special topic. Wind power is one of many forms of energy production. As a subject of study, wind power is an interesting issue because its importance in industrial-scale energy production has been relatively small in Finland. In contrast, Denmark, which belongs to the same electricity system, had 184.5 times more industrial-scale wind power per surface area compared to Finland in the end of the year 2008 (EWEA, 2009).

Wind power will play a significant role also in the future on global, EU and Finnish level in increasing the share of renewable energy production forms by the year 2020 (COM, 2007a; COM, 2007b). The Finnish national long-term climate and energy strategy includes a target to increase the current wind energy production of 0.4 TWh to 6 TWh by the year 2020 (Finnish Government, 2008). Wind power was chosen as a special topic also because the researcher had the possibility to collect material related to it. Investment decision processes connected to the wind power industry are a relatively new research topic globally, especially from the point of view of limiting the research geographically. Wind power, one among various forms of energy production, is a topical issue within the context of the research, and the results of this research contribute to international scientific discussion. Currently, efforts are made globally to find new ways to increase renewable energy. In such a situation, wind power plays an important role compared to other forms renewable energy production due its technologically advanced nature, availability and cost-effectiveness.

1.4 Structure of the Dissertation

This dissertation consists of five individual, public articles substantiated by research and containing true and general information. The articles are interconnected and constitute an entity, in which the area of research is examined from both local and global perspective, and the energy industry is examined as a whole and through a single form of energy production. Energy production from wind power is treated as a specific subject of research.

The articles of the dissertation are linked through various dimensions. Figure 2 illustrates the complex field of energy industry investments. The articles that examine the energy industry in general are on the left side of the cone, while the articles that focus on wind power are on the right side. Towards the tip of the cone, moving from strategic to operative level, the nature of the research is more concrete and closer to practical solutions.

The dissertation investigates the energy industry primarily on the macro level. In general, the research takes place between a moment when an investor in the energy sector starts to look for an appropriate type of energy production and a moment when the investor makes the decision to start investing in a certain type of energy production solution. In line with the framework of the research, the moment of investing can be defined as a moment when the energy investor commits to a certain form of energy production and consequently to a certain equipment supplier or policy solution.

In the research, the competitive priorities and facilitators of energy industry investments are examined on various levels. Article 1 concentrates on the energy industry in general and looks at the effects of different competitive priorities in relation to one another. Article 2 focuses on issues related to wind power from the point of view of investors and equipment suppliers. Article 3 consists of a more thorough analysis of the relations between the factors affecting wind power. Article 4 investigates investment decision processes in the energy industry more extensively through a strategic perspective. Article 5 is again focused on wind power and studies the ways in which the different framework factors affecting investment decisions depend on one another and affect the preconditions for investments.

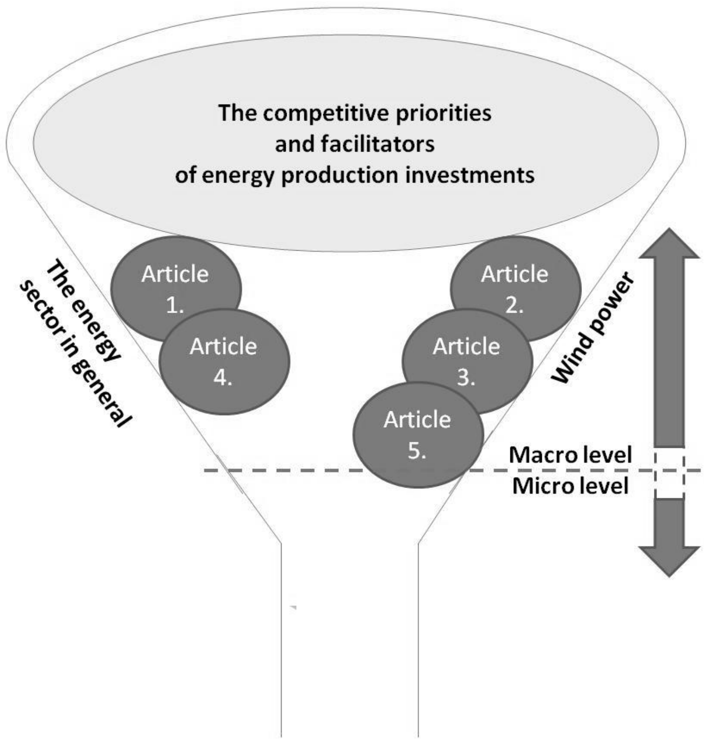


Figure 2. The relation between the articles examined as parts of the dissertation as a whole.

In the dissertation, wind power serves as an example of different forms of energy production. In Figure 2, the horizontal level of the cone includes all the different forms of energy production. As illustrated by the figure, micro-level research concerning more specific choices and the implementation and comparison of energy production projects starts from where the examination in this dissertation ends. This type of micro-level research means detailed analyses carried out in a certain geographical area and focusing on a chosen form of production. In practice, and for example from the point of view of an energy investor, this entails choosing the wind power equipment supplier or the location for the wind power project within the framework area.

With respect to the decision-making in a company organisation, and taking the tripartite division suggested by Kunnas (2009), this research can be positioned between the strategic issue management meeting level and strategic issue management system level. Consequently, the decision-making examined in this research takes place in the organisational level of Kunnas's (2009) categorisation.

The research articles proceed chronologically from the general to the particular. Part I of the research introduces the background of the research, the most important sections of the literature review, the methodology and the results of the research as well as a summary of the articles that the research is based on. The conclusion and discussion section examines the results of the research.

Part II of the research consists of five published scientific articles. These publications constitute an entity, in which they are in chronological order based on the date of publication.

Table 2 describes the division of the dissertation into two parts (Part I and II).

Table 2. The structure of the dissertation.

Part I: Overview of the dissertation
1. Introduction
Description of the background, review of the previous research, research gaps , objectives and research questions
2. Methodology
Explanations of the research environment, strategy and method and data collection and analysis
3. Summary of Publications and Findings
Short summaries of all the papers and main findings
4. Conclusions
Justification of the dissertation and analysis of the main findings by an energy sector expert
Part II: Publications
Publication 1
The model based on the analytic hierarchy process for dynamic decision making in the energy industry: case analysis of investment energy production in Finland
Publication 2
Competitive priorities of investment strategy: case wind power
Publication 3
The competitive priorities of the wind power investment
Publication 4
The fast strategy and dynamic decisions in energy industry
Publication 5
Acceptability of wind power

2 METHODOLOGY

Philosophy of science is an area of philosophy that investigates the nature and general foundations of scientific data as well as scientific activity. It examines the concepts, theories, methods and problems of science as well as scientific reasoning and explanation (Ojanen, 1999). Philosophy of science can be divided into two parts: one that studies science in general and can be further divided into epistemology and ontology of science, and one that studies the foundations of individual disciplines and scientific theories (Worrall, 1998).

Two central questions concerning science are: 1) What are the objectives of science? and 2) How should the results of science be interpreted? Scientific realists take the view that science pursues truth, and that scientific theories should be regarded as true, approximately true or probably true. On the contrary, scientific antirealists or instrumentalists claim that science does not pursue (or at any rate does not succeed in its pursuit of) truth, and thus scientific theories should not be regarded as truths (Levin and Leplin, 1984).

Scientific theories have two tasks: on the one hand to explain phenomena, and on the other hand to provide predictions of phenomena. In scientific explanation, the phenomenon to be explained is connected to other phenomena, which, it is claimed, explain it. A theory is considered to have greater explanatory strength than another theory explaining the same phenomena when it is capable of providing all the explanations that the other theory offers and, in addition, explains reasons behind facts that the other theory cannot explain.

Above all, a research paradigm describes the research assumptions of reality and knowledge (Creswell, 2003; MacKenzie and Knipe, 2006). There are four alternative research paradigms: postpositivist, constructivist, advocacy /participatory and pragmatic (see Figure 3).

Postpositivism Determination Reductionism Empirical observation and measurement Theory verification	**Advocacy/Participatory** Political Empowerment issue-oriented Collaborative Change-oriented
Constructivism Understanding Multiple participant meanings Social and historical construction Theory generation	**Pragmatism** Consequences of actions Problem-centered Pluralistic Real-world practice oriented

Figure 3. The four research paradigms.

Source: Creswell, 2003; MacKenzie and Knipe, 2006

Accordingly, there are four different types of epistemological starting points, which influence the nature of the research and the use of the research data.

In connection with the postpositivist research paradigm, quantitative methods are mainly used. As for the collection of research material, the object of the study is independent of the researchers, and knowledge is discovered and verified through direct observations or measurements of phenomena. Within the constructivist research paradigm, qualitative methods are primarily utilised but the use of quantitative methods is also possible. As for the collection of research material, knowledge is established through the meanings attached to the phenomena studied, researchers interact with the subjects of study to obtain data, the inquiry changes both the researcher and the subject and knowledge is context- and time-dependent. With respect to the advocacy/participatory research paradigm, both quantitative and qualitative research methods are used. There are also various methods that can be used in the collection of data. Within the final, pragmatic paradigm, quantitative and/or qualitative research methods are utilised. The research material collection methods used are similar to those used in connection with the postpositivist and constructivist paradigms. These methods include for example interviews, observation and different kinds of tests (Creswell, 2003; MacKenzie and Knipe, 2006).

Following the definitions described above, pragmatism presents the strongest philosophical starting point for this research, although it also involves features related to the other paradigms. The focus of the research is on real-world practice oriented problems, and the research produces new knowledge.

The aim of the research is to make use of the researcher’s empirical observations through deductive reasoning. The methodological framework of the research is based on several different methods. The information that the research produces is substantiated public, true and general information, whose validity, reliability, relevancy and practicality is tested in the articles and the conclusion section of the study.

2.1 Research Environment and Strategy

The research environment consists of the complex field surrounding the energy industry. On the one hand, the energy industry is global due to the equipment supplies, availability of fuels and political framework. On the other hand, it is local due to legislation and the limited transmittability of the end products. The electricity, heat and process steam generated in power plants must be consumed close to the production point. From a strategic perspective, the research constitutes an entity, which examines company strategies and the unforeseeable, external or internal strategic issues that affect them.

The development of Finnish energy production has been described by Moilanen (2009) based on a four-phase process that comprises: utility start-up (years 1889-1938), institutionalisation (1939-1970), increasing demand (1971-1994) and deregulation (1995-2005). The name of the last period, deregulation, is derived from the opening of the electricity market. However, considering the Finnish energy industry as a whole, it can be said that regulatory measures are still in use, for example in the granting of permissions to build nuclear power and various taxation measures. The pricing of electricity varies in different countries. In Finland, the Electricity Market Act, which entered into force in 1995, opened the Finnish electricity market to competition. After this, the Finnish energy market has been influenced especially by the EU CO2 emission trading scheme, which has increased the production costs of certain forms of energy production. Its impacts on the electricity market and electricity consumers have been studied for example by Kara et al. (2008).

According to Moilanen (2009), during the deregulation period, the key technological innovation was wind power, which also supports the fact that this research participates in the scientific discussion in the field.

As for the temporal framework, the research is focused, particularly with respect to wind power, on a period when there are plans being made to build new wind power units in Finland, the country of research. Compared to the other EU-27 countries, a relatively small amount of energy is derived from wind power in Finland. This has its impact on the research environment. In Finland, the manufacture of wind power-related equipment is more common than energy production from wind power. On the other hand, from the perspective of the energy industry as a whole, Finland is in a situation in which more energy production plant investments are planned for the next decade than were made in the past decade.

The choice of the research strategy and methods should always begin with the purpose and aims of the research. This research has two different kinds of objectives: the first is to understand the energy production investment process, and the second is to find the competitive priorities which have an effect on energy production investments in the research area. Thus, one part of the research is explorative and the other more normative in nature. However, both parts of the research are based on the same philosophical background: hermeneutics. Whereas positivism, the other of the main philosophical research approaches, aims at explaining issues and their causal relations, hermeneutics aims at understanding them (Olkkonen, 1993).

The research strategy is based on scientific research built on a strong empirical background. The main principles of the strategy are publicity, criticalness and autonomy. The research strategy was created starting from scientific problems, with the purpose of solving them with scientific methods and making use of the researcher’s empirical experience.

The research strategy utilises features related to action research as well as methods of case research. Action research is a form of research mainly of qualitative nature, the aim of which is to develop the organisation researched through affecting its operating methods. Important characteristics of action research are the objective to have an effect as well as the participation of the researcher in the action and everyday operation of the organisation in question (Kemmis and Wilkinson, 1998).

The research was started with surveying the present situation and investigating fundamental questions affecting the research. These initial analyses were used to formulate an operations model, or impact program, for the research. Full interventions were not carried out as part of the research but an evaluation was performed, mainly using the AHP method. The operations model, characteristic of action research that had been developed was implemented indirectly by presenting the results of the research to experts in the field (see section “Relevancy and Practicality of the Study”). The research included interactive discussions, which were used to collect crucial preliminary data for the research.

Following case research methods, samples of experts in the field were utilised in the study. Usually, the focus in case research is on a thorough and comprehensive examination of a small number of cases instead of using statistical analysis on a large and representative sample (Eisenhardt, 1989).

The research strategy was formulated in such a way that it could be used to produce five separate scientific articles which would serve as individual entities but also constitute a whole that would respond to the research questions. The findings of the papers included in this dissertation are summarised in Section 3. The selected papers explain the basic framework and provide a general overview of the research areas in question. The collection of published papers comprising this dissertation is summarised in Table 3 and Table 4. The relations between the articles and the research questions as well as the research methods used in each publication are summarised in Table 6. Following the strategy, the separate studies were carried out in such a way that the data produced by them gradually deepened the knowledge gained from the previous studies.

The research strategy was divided into two parts, concerning the energy industry in general and wind power as a special issue. The questions related to the energy industry in general were examined using a wider frame of reference, while the issues concerning wind power were examined by focusing on the characteristics of the specific form of energy production. This provided the research with both width and depth in its examination of the operation of the energy industry.

The primary focus on the perspective of investors was chosen because investors have a key role in combining and evaluating different factors as part of an investment decision. Investors' operating preconditions are influenced by an environment that enables or prevents the formation of new energy production capacity in the country in question. Based on the research strategy, the research is mainly concentrated on Finland since, from the perspective of investors, the background factors affecting the implementation of energy production investments (e.g. political, legislative and economic) are in part country- and continent-specific.

From a temporal perspective, the research is primarily focused on the moment of investment decision since it is then that investors truly have to consider the characteristics of investment projects. With respect to the research strategy, this was a conscious choice for it enabled the examination of the moment when decision-makers make decisions that are crucial in terms of business.

2.2 Research Approach and Methodology

Depending on the selected research problem, the available information, the level of available information and the final results the research aims at, several research approaches can be used. The chosen research approach should provide instruments with which to achieve the research objectives.

Scientific data differs from everyday information in that it must be accurately substantiated. One solution is to rely on inductive reasoning (Eisenhardt, 1989). According to its principle, if something is valid in all the observed cases, it is considered valid in all cases. In deductive reasoning, however, the conclusion is true if the premises are true (Yin, 2009). The latter method is commonly used particularly in mathematics. The strategy of this research includes aspects of both inductive and deductive reasoning, while induction is the dominant one owing to the case researches (Yin, 2009; Eisenhardt, 1989; Kovács and Spens, 2005). In them, inductive reasoning is utilised for example through the Analytic Hierarchy Process (AHP) method. As for deductive reasoning, it is made use of in the TEA model included in the fifth article. In the model, the starting point is deductive, and the analysis is supported by inductive reasoning. Viewing the research as a whole, it can be said that the research strategy mainly involves abductive reasoning, in which reasoning is based on the best explanation available.

In principle, the reasoning in the research is based on facts generally accepted in the energy industry, which are supported in the research through empirical observation. The reasoning is validated by the fact that it is rational and probable, although it is of course possible that the chain of reasoning involves an exception. In such cases, the hypothesis is supported by investigating the probability of an exception, which strengthens the accuracy of the hypothesis.

Abductive reasoning is not deductively valid; the conclusion is not a necessary result of the premises, and it can be untrue even if all the stated premises were true (Kovács and Spens, 2005). Generally, however, the conclusion is “sufficient”, and scientific explanations and theories are defended abductively for practical reasons. In the research, abductive reasoning was utilised deliberately even though it also presents an important challenge from the perspective of philosophy of science, for abductive critique is used to test the compatibility of a theory with the available empirical material and assumptions, and the theory does not need to be an inevitable result of the premises.

However, it must be noted that a certain phenomenon can be explained with alternative theories or explanatory models, or at any rate there are alternatives that are possible and cannot be excluded as impossible. In general, and also in this research, theories are defended through abductive reasoning, based on the fact that they explain the empirical material in question better than other theories.

The design of this research was constructed in such a way that it met the epistemological and ontological world of the research. Research epistemology addresses how we come to know reality by identifying particular practices. Ontology, on the other hand, explains the relation of research to the real world. In this research, epistemological topic definitions are made in the section that concerns the goals of the research. The ontological part is treated through observations that are made based on the research results. The empirical observations of the research reinforce its ontological relation to the real world.

Quantitative research refers to research in which accurate and calculatory, often statistical methods are used. In quantitative research, the researcher aims at collecting empirical observation material for a study. By examining the material, the researcher seeks to understand a certain societal phenomenon and make generalisations based on the material.

Data collection methods used in quantitative research were utilised in the publications, including literature reviews, interviews and formal questionnaires. Quantitative research is suitable for studies that concern large groups of people. It cannot be used to acquire comprehensive information on single cases. Statistical models are often used in quantitative research.

In qualitative research, by contrast, the objective is to understand the phenomenon studied. This means examining the meaning or purpose of the phenomenon and acquiring a comprehensive and deeper understanding of the phenomenon (Hirsjärvi and Huttunen, 1995). In general, a qualitative research does not have a hypothesis. The aim is to proceed on the basis of the material with as few assumptions as possible. One of the purposes of qualitative research is to create new hypotheses for subsequent quantitative research. Discretionary sampling is usually used in qualitative research. The number of the entities to be studied is relatively small, and they are examined thoroughly, with the emphasis on the quality of the material. Still, the size of the material is not insignificant for it should be comprehensive in relation to the type of analysis and interpretation performed. The aim is that the selection of the material is appropriate for the purposes and theoretically substantiated. Qualitative research is characterised by inductive reasoning that aims at generalisations and conclusions made on the basis of issues arising from the material. The objective is to examine the material in an elaborate and detailed manner and identify significant themes. Statistical generalisations are not part of the objectives (Eskola and Suoranta, 2000).

According to Bryman (1988), comparing the qualitative and quantitative research approaches with one another, it can be said that the relation of the researcher and research object to the research is distant in quantitative research, whereas in qualitative research they are close. Typically, quantitative research strategies are structured and the material used hard and reliable. In contrast, qualitative research strategies are usually unstructured and the material used rich and deep.

Therefore, a qualitative research paradigm was chosen as the main paradigm for this study, although the individual research publications also include some aspects of quantitative research. With respect to data collection for this research, both qualitative and quantitative methods were used. This is in line with the definition that qualitative research is used to create theories, while quantitative research is used to confirm them (Bryman, 1988).

In this research, an innovative and theoretically justified solution was created for a practical problem. The research approaches used in management accounting can be categorised in different ways. Neilimo and Näsi (1980) have identified four different research approaches: nomothetical, decision-oriented, action-oriented and conceptual. In their article published in 1993, Kasanen, Lukka and Siitonen added a constructive approach to the above categories. The relations between the research approaches are illustrated in Figure 4.

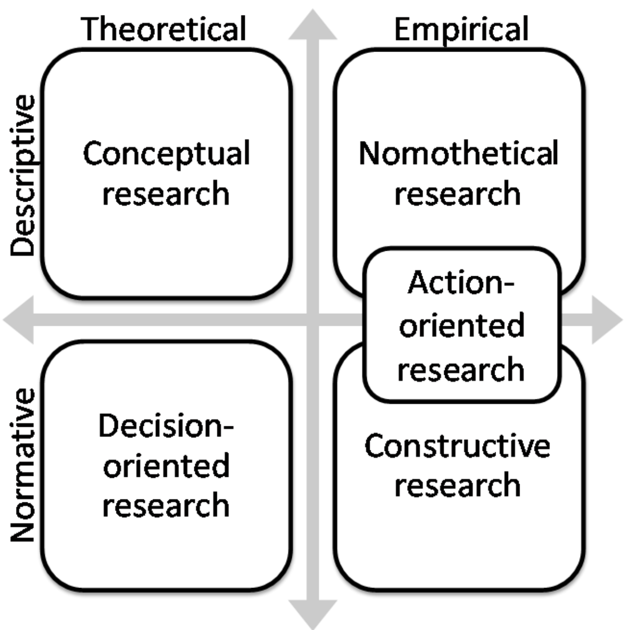


Figure 4. The typology of the typical research approaches in management accounting.

Source: Kasanen et al., 1993

In the figure above, the research approaches are organised according to the purpose and method of acquiring information. The purposes are divided into descriptive and normative and the acquiring methods into theoretical and empirical. This research involves descriptive features in that it explains how things are in reality. As for the normative features, the research includes them in the sense that it is aimed at finding results that can be used to prepare guidelines or methods to develop operations. Regarding the horizontal axis, the research also contains features of empirical research since it aims at finding features among the individual cases that are statistically reasonable and related to the population within the framework of the research.

According to Neilimo and Näsi (1980), the characteristics of action analytical research, which this dissertation also includes, are the following:
– teleological explanation,
– action science, study of human sciences,
– the purpose is understanding,
– generally the empirical material used includes only few entities,
– there is no established set of methodological rules and
– researches often produce conceptual systems of different levels.

In this research, the characteristic related to the constructive research approach is the production of an innovative and theoretically substantiated solution to a practical problem. The results generated by this research approach have been shown to be applicable to practice. Figure 5 illustrates the characteristics of the constructive research approach.

Figure 5. The constructive research approach.

Source: Kasanen et al., 1993

In the constructive research approach, emphasis is placed especially on creativity. According to the principle of the approach, research results must be tested with either a strong or a weak market test. The strong market test means that the results are tested in practice, on the basis of which they can be verified. The weak market test, on the other hand, does not require testing as concrete as the strong test (Olkkonen, 1993). In this research, a weak market test was used to strengthen the constructive research approach. The weak market test was implemented by interviewing experts in the industry. The results of the interviews are analysed in paragraph 4.3.

The purpose of the concept analytical research approach is to develop conceptual systems concerning the phenomenon studied on the basis of empirical data and theories. These systems should serve a certain purpose, and the established systems can be entirely new or revised versions of known systems (Olkkonen, 1993). The conceptual systems created through research can be either declarative or recommendatory (Neilimo and Näsi, 1980).

Arbnor and Bjerke (1997), on the other hand, have identified three methodological approaches based on debates concerning research paradigms (Figure 6).

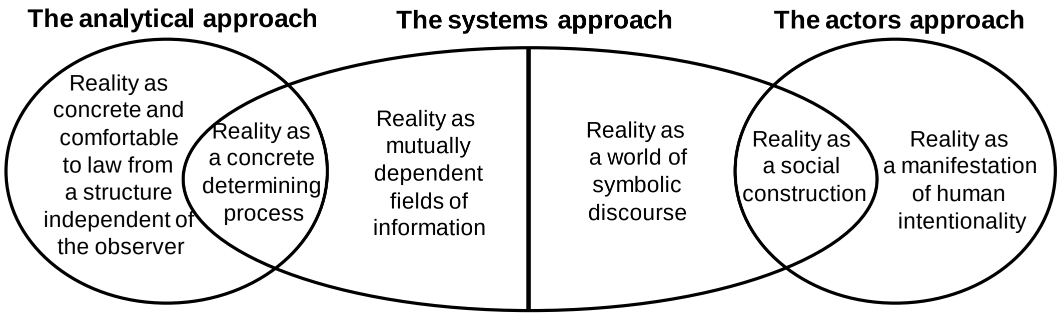


Figure 6. The three methodological approaches.

Source: Arbnor and Bjerke, 1997

The decision-oriented approach (management science-oriented) typically uses the method of deduction and involves building mathematical models of complex business situations, using e.g. software programs to gain insight into the research situation and to communicate the resulting insight and recommendations (Kasanen et al., 1993; Lawrence and Pasternack, 2002). In this study, mathematical models and software were utilised in the analysis of the data. For this reason, the research involves aspects related to the decision-oriented approach.

Viewing the chosen research approach against Arbnor and Bjerke's (1997) categorisation, it is clear that this research involves features of all three research approaches determined by them. The main emphasis in this research, however, is on the system approach described in Figure 6. On the other hand, taking Neilimo and Näsi's (1980) definition, the methods used in this research include characteristics related to the action analytical and constructive research approaches. In addition, the research also involves features associated with the concept analytical and decision-oriented approaches. According to Olkkonen (1993), several research approaches can be used in one study.

The assessment of the contributions of the research to the existing theoretical framework has been carried out through literature reviews. In each publication, different kinds of views were compared and research gaps identified with the help of literature, and based on these analyses, a literature review was produced, which contained features related to the concept analytical research approach. As for the empirical part of the research, it consists of individual entities that respond to the research questions and have been substantiated through the publications.

2.3 Data Collection and Analysis

The data collection was carried out with the help of a literature review, the researcher's observations, interviews, teamwork and formal questionnaires. The literature review included in each publication has helped the researcher to become closely acquainted with the scientific framework of the research area. Through the literature review, each publication has been rendered part of the scientific discussion. The researcher's observations had a significant role in the collection of data.

The researcher's observations on the research area have been collected extensively in a Nordic and global context. The researcher works in the energy industry, and his work involves investment decision-making. This has enabled a comprehensive understanding of the background of the research as well as the possibility to examine issues related to the research in detail in the conferences, meetings and other functions arranged in the field since 2005.

Regarding wind power, the special topic of the research, the researcher has been partly responsible for the preparation of investment decisions concerning wind power projects in Finland, Norway and Estonia. The researcher has participated in the formulation of the business plan for a new wind power construction company, whose objective is to aim at the global equipment supplier market. In addition, the researcher has participated in the analysis of investment decisions concerning projects in industrialised developing countries (e.g. China, India and Thailand), targeted at building renewable energy and reducing carbon dioxide emissions and implemented with the help of financial instruments.

The data collection was formalised with the help of formal questionnaires and interviews carried out in connection with the publications. The questionnaire used in the interviews was loosely structured. This was because the phenomenon in question was relatively complex, and it was probable that different representatives of companies or experts would talk about equivalent issues using different kinds of terminology.

The research results have been analysed with different methods according to the different publications. The primary method used in the research was the Analytic Hierarchy Process (AHP). Other methods utilised were, among others, the responsiveness, agility and leanness model (RAL model) and the fast strategy approach.

The Analytic Hierarchy Process (AHP) published by Saaty (1977; 1980) is a model of the way in which the human mind conceptualises and structures a problem. Dating as early as the 1970s, the method has been used in various decision settings in the design of alternative future outcomes for a developing country (Saaty, 1977), the evaluation of political candidates (Saaty and Bennett, 1977) and the allocation of energy resources (Saaty and Mariano, 1979).

The AHP is a powerful and flexible decision-making process that helps in prioritising and making a decision when both the qualitative and quantitative aspects of a decision need to be considered. By reducing complex decisions to a series of pairwise comparisons, then synthesising the results, the AHP not only helps decision-makers to arrive at the best decision, but also provides a clear justification of what the important decision is. The AHP is a multi-attribute decision instrument, and its goal is to integrate different measures into a single overall score, in which the decision alternatives are ranked using pairwise comparisons of the chosen attributes.

The AHP model is a decision-making framework that assumes a one-way hierarchical relationship between different decision-making levels. The AHP model has three basic steps (Saaty, 1980; Saaty, 1999):

Step 1 The development of a decision hierarchy. The top element of the hierarchy is the overall goal of the decision model. The hierarchy is a system in which one group of factors influences other sets of factors.

Step 2 Pairwise comparisons are conducted to estimate the relative importance weights (or allocations) of the various elements on each level of the hierarchy.

Step 3 The obtained weights are integrated to develop an overall ranking of the decision alternatives.

The hierarchy consists of the overall objective, criteria, subcriteria and decision alternatives, described in Figure 7.

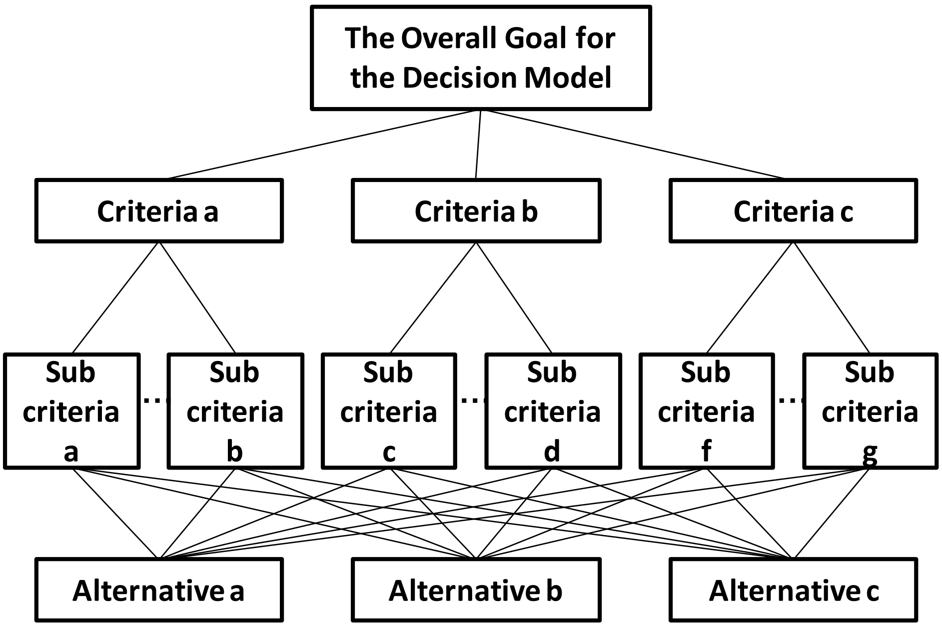


Figure 7. The hierarchy structure of the AHP model can be used to find an overall goal for the decision problem.

Source: Rangone, 1996

The structure of the AHP method helps to recognise the factors affecting decision-making more accurately and also to acknowledge the mutual correlation between each factor. The AHP makes it possible to combine accurate and measurable knowledge (costs, interest rates, measures) with intuition and personal valuations within the same decision-making model.

The results acquired with the help of the AHP method were examined using, among others, the inconsistency ratio (ICR or IR) and implementation index (IMPL). The ICR was utilised to assure the internal validity (credibility) of the pairwise comparison results. It is suitable as such for the analysis of AHP method results when using the traditional scale (9…1…9), as was done in this research (Saaty, 1980). Variations of the ICR also exist, which can be used with different scales (see e.g. Salo and Hämäläinen, 1997).

The ICR is a ratio or percentage expressing the time that decision-makers are inconsistent in making judgments on a set of particular elements. According to Takala (2002), only matrices with an ICR value of 0.10 or less can be used for reliable decision-making (and 0.30 or less in smaller groups with no more than 10-20 highly competent experts). The important features, the inconsistency ratio and the axioms, as well as reciprocal condition, homogeneity, dependence and expectation are the basis for AHP applications (Takala, 2002). If the ICR of an answer is less than 0.3, the answer is internally valid. If not, the result in question should not be accepted, and, if possible, the expert should have a possibility to check again that the answer is exactly as it was meant to be.

The implementation index (IMPL) was used for evaluating the usability of the results from the AHP assessments. The IMPL value is calculated by dividing the standard deviation of attribute assessment results by the value of the corresponding average value (Takala, 2002). In addition to calculating the IMPL, variances calculated based on the IMPL as well as the deviations were examined in order to validate the IMPL results. Variance describes how far the values of a random variable typically lie from its expected value. The variances were calculated from the IMPL values of individual answers, and they were compared with the geometric mean index.

Mathematical software programs were made use of in the analysis of the research results, for example Expert Choice's EC11.5 AHP software program and Microsoft's Microsoft Office Excel 2007 spreadsheet software program.

Expert Choice's EC11.5 AHP software program is a robust, desktop-based application, which enables researchers to prioritise objectives, evaluate alternatives and achieve alignment by way of the AHP method.

In creating the AHP method hierarchy, the responsiveness, agility and leanness model (RAL) was made use of. The RAL concept has created an understanding of the success factors in logistics, but it is relevant for all strategic operations and management of operations, as well as for manufacturing and investment strategies (Takala, 2002).

The main dimensions of the RAL model are:

– Responsiveness, which means the speed by which the system satisfies unanticipated requirements.
– Agility, which means the speed by which the system adapts to the optimal cost structure.
– Leanness, which means minimising waste in all resources and activities.

In the middle of the triangle is flexibility, which is the focused core concept. It signifies the product mix, volatility in conditions (changes in volumes), complexity (technology level and the number of modules and modularity) and life cycle flexibilities (Takala, 2002; Takala and Toshev, 2007).

The AHP was chosen as the primary method of the research since it is designed to solve complex entities. Carrying out the research, it was essential to identify the most significant factors to be focused on and at the same time separate areas irrelevant to the research.

The research results were assessed as for their validity and reliability. The validity and reliability of the data collection methods used are the most important features determining the reliability of the research results. Yin (2009) lists four criteria for judging the quality of any research, which are construct validity, internal validity, external validity and reliability. Patton (1990) proposes that the credibility of a qualitative inquiry depends on the distinct but related inquiry elements:

– Rigorous techniques and methods for gathering high-quality data that are then carefully analysed with attention to issues of validity, reliability and triangulation.
– The credibility of the researcher.
– Philosophical belief in the phenomenological paradigm, that is, a fundamental appreciation of naturalistic inquiry, qualitative methods and holistic thinking.

In addition, the relevancy and practicality of the study were evaluated through an analysis and with the help of the views collected from experts in the industry. The results of the validity and reliability of the study are analysed in paragraph 4.2 and relevancy and practicality of the study are analysed in paragraph 4.3.

3 SUMMARY OF THE PUBLICATIONS AND FINDINGS

This section will summarise all the findings of the papers included in this dissertation. The selected papers contain an explanation of the basic framework used and a general overview of the research areas in question. The collection of the published papers included in this dissertation is summarised in Table 3 and Table 4.

The second, third and fifth publication concentrate specifically on wind power. The first and fourth publication focus on problems related to the energy industry generally. As for the conceptual focus, the key concepts are multi-criteria decision-making and strategy management.

Table 3. The publication and title of the publications included in the dissertation.

No & Publication Publication I: Int. J. of Nuclear Governance, Economy and Ecology	**No & Publication** Publication II: Int. J. of Sustainable Economy	**No & Publication** Publication II: Int. J. of Management and Enterprise Development (forthcoming)	**No & Publication** Publication IV: Int. J. of Management and Enterprise Development (under review process)	**No & Publication** Publication V: Int. J. of Innovation and Learning (forthcoming)
Appendix Appendix 1	**Appendix** Appendix 2	**Appendix** Appendix 3	**Appendix** Appendix 4	**Appendix** Appendix 5
Title The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry: a Case Analysis of Investment Energy Production in Finland	**Title** Competitive Priorities of Investment Strategy: Case Wind Power	**Title** The Competitive Priorities of the Wind Power Investment	**Title** The Fast Strategy and Dynamic Decisions in Energy Industry	**Title** The Framework Factors Affecting The Acceptability of Wind Power

Table 4. The conceptual focus and purpose and aim of the publications included in the dissertation.

No & Publication Publication I: Int. J. of Nuclear Governance, Economy and Ecology	**No & Publication** Publication II: Int. J. of Sustainable Economy	**No & Publication** Publication II: Int. J. of Management and Enterprise Development (forthcoming)	**No & Publication** Publication IV: Int. J. of Management and Enterprise Development (under review process)	**No & Publication** Publication V: Int. J. of Innovation and Learning (forthcoming)
Conceptual Focus Multi-criteria decision-making; Analytic hierarchy process; Finnish energy sector	**Conceptual Focus** Multi-criteria decision-making; Analytic hierarchy process; Responsiveness, agility and leanness model; Wind power	**Conceptual Focus** Multi-criteria decision-making; Strategic management; Enterprise development; Energy industry; Wind power	**Conceptual Focus** Emerging strategic issues; Strategic management; Sense and response; Enterprise development	**Conceptual Focus** Wind Power; Strategic management; Innovation; Conditions of investment
Purpose & Aim The goal of the research was to find out, define and evaluate the major factors of decision-making processes in the energy industry, especially in Finland.	**Purpose & Aim** The goal of the research was to evaluate the major factors affecting the decision-making process of investments made in wind power, especially in Finland, from the investors' and suppliers' point of views.	**Purpose & Aim** The goal of the research was to analyse the decision-making process and competitive priorities of investment strategies from wind power investors' point of view and to compare the findings with the opinions of wind power unit suppliers.	**Purpose & Aim** The main goal of the research was to link together different strategic models and then modify the special agility strategy model for energy industry. The subgoal was to analyse competitive priorities of the energy investments.	**Purpose & Aim** The goal of this research was to evaluate and analyse the factors that have an effect on the acceptability of a wind power investment in a decision-making situation.

The five papers included in this dissertation are linked with the core research questions of the thesis, and the questionnaire data was also used as empirical data for the papers.

As for the contribution of the papers' authors, two of the five papers comprising this dissertation are the outcome of cooperative efforts. For the purpose of evaluating these two papers, a clear distinction needs to be made as to who has done what. The research has been a process that has been principally undertaken by individuals cooperating and confronting mutual ideas. In any case, one division concerning this research is clear, namely that all the empirical effort has been the individual contribution of the thesis author. Even so, a more detailed description of the contributions to each paper is made in Table 5.

Table 5. The researchers' contribution to each publication.

Publication	Author(s)	Contribution
Publication I	Tomi Mäkipelto* Josu Takala *Corresponding author	This paper is a joint effort between two authors. However, the second author agrees that most of the work was done by the thesis author, particularly in providing the core idea, data collection and analysis. The second author proposed the use of the AHP method in the research and presented the paper at a conference. The paper was presented at the IAMOT 2008 conference and then submitted for publication in IJNG2E.
Publication II	Tomi Mäkipelto	This paper was written by the thesis author. The paper was presented at the MIC 2008 conference and then submitted for publication in IJSE.
Publication II	Tomi Mäkipelto	This paper was written by the thesis author. The paper was presented at the IAMOT 2009 conference and then developed further to be submitted for publication in IJMED.
Publication IV	Tomi Mäkipelto* Kongkiti Phusavat *Corresponding author	This paper is a joint effort between two authors. However, the second author agrees that most of the work was done by the thesis author, particularly in providing the core idea, data collection and analysis. The second author was proposed the use of methods and the scope of research. The paper was presented at TIIM 2009 and then developed further to be submitted for publication in IJMED.
Publication V	Tomi Mäkipelto	This paper was written by the thesis author. The paper was presented at the TIIM 2010 conference and then developed further to be submitted for publication in IJIL.

The researcher is independently responsible for the research as a whole. The objective of cooperation in connection with the individual publications has been to gain a more comprehensive knowledge of the scientific field and make use of international expertise. Thus, the research is also linked with international research.

In the publications, different methods were used in the analysis of the results. The role of the AHP method is emphasised in the first and second publication. On the other hand, the role of the analysis and reflection by the researcher is emphasised in all the publications according to the chosen research method. Table 6 summarises the relations between the articles and the research questions as well as the research methods used in each publication.

Table 6. The research questions, methods of analysis and papers combined.

No & Publication Publication I: Int. J. of Nuclear Governance, Economy and Ecology	**No & Publication** Publication II: Int. J. of Sustainable Economy	**No & Publication** Publication II: Int. J. of Management and Enterprise Development	**No & Publication** Publication IV: Int. J. of Management and Enterprise Development	**No & Publication** Publication V: Int. J. of Sustainable Economy
Relation to Thesis Research Questions This paper responds to the first thesis research question: What kinds of factors have the largest impact on the life-cycle profits of large-scale energy production investments especially in Finland?	**Relation to Thesis Research Questions** This paper responds to the third thesis research question: What are the differences of the major factors of decision-making processes affecting investments from the investors' and suppliers' point of view?	**Relation to Thesis Research Questions** This paper responds to the third thesis research question: What are the differences of the major factors of decision-making processes affecting investments from the investors' and suppliers' point of view?	**Relation to Thesis Research Questions** This paper responds to the second thesis research question: How can the theories of agile strategic management be combined with the competitive priorities affecting energy production investment decisions?	**Relation to Thesis Research Questions** This paper responds to the fourth thesis research question: What kind of relation do the framework factors affecting the acceptability of invest-ment projects have to the other decision-making factors affecting the invest-ment preconditions?
Method of Analysis Statistical analysis; AHP; Analysis and reflection by the researcher	**Method of Analysis** Statistical analysis; AHP; RAL model; Analysis and reflection by the researcher	**Method of Analysis** Statistical analysis; Analysis and reflection by the researcher	**Method of Analysis** Literature; Analysis and reflection by the researcher	**Method of Analysis** Statistical analysis; Analysis and reflection by the researcher

The novelty of the dissertation and each publication can be examined in detail. The novelty of the first publication is related to the creation of an AHP model for the Finnish energy industry and the analysis of its results. The novelty of the second publication is based on the specification of the general model produced in the first publication, with the focus on issues related specifically to wind power.

The novelty of the third publication concerns the identification of the most important differences between investors and equipment suppliers regarding investment decisions. The novelty of the fourth publication is related to the creation of a strategic management agility model for companies operating in the energy industry. The novelty of the final publication concerns the identification of the framework factors affecting investment decisions in wind power projects and the analysis of their relation to one another from the point of view of investors within the chosen framework. Table 7 lists the novelty and findings of each publication.

Table 7. The novelty and findings of the publications combined.

Publication	Novelty	Findings
Publication I	An AHP model related to decision-making and suited specifically to the Finnish energy industry was created and its results analysed.	The results showed that the main factors that have an effect on energy sector investments' life-cycle profits are both financial and political.
Publication II	An AHP model related to decision-making and suited to wind power production was created by making use of existing theories.	The results showed that some investors' and suppliers' expectations of the competitive priorities of investment strategies' main factors differ from each other.
Publication II	The most important differences related to investment decisions between investors and equipment suppliers were identified.	The most important factors affecting wind power investments at the moment of investment decision: - Minimise investment and maintenance costs - Maximise the performance and reliability of the investment - Optimise the life span of the investment
Publication IV	A model of agile strategic management was created for companies in the energy industry.	The research findings give companies a possibility to reform their strategies to be more sensitive and also give advice as to how to create their own fast and dynamic decision model.
Publication V	The relation between the frame-work factors affecting the acceptability of investment projects and the other decision-making factors affecting the investment preconditions was analysed.	The results of this research help utility investors and country-/municipality-level decision-makers to understand how the operational environment affects energy investments that are important for the society as well as the factors that have an effect on the growth of renewable energy forms.

Regarding the dissertation, the main findings consist of the answers to the research questions. The analysis of these answers is included in the conclusion and discussion section.

3.1 The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry: Case Analysis of Investment Energy Production in Finland

The goal of the research was to find out, define and evaluate the major factors of decision-making processes in the energy industry especially in Finland. It was necessary to pay special attention to the economical situation of the energy companies since not all business theories were applicable due to the specific nature of the sector. In the study, an AHP model was constructed around the research problem (see Figure 8).

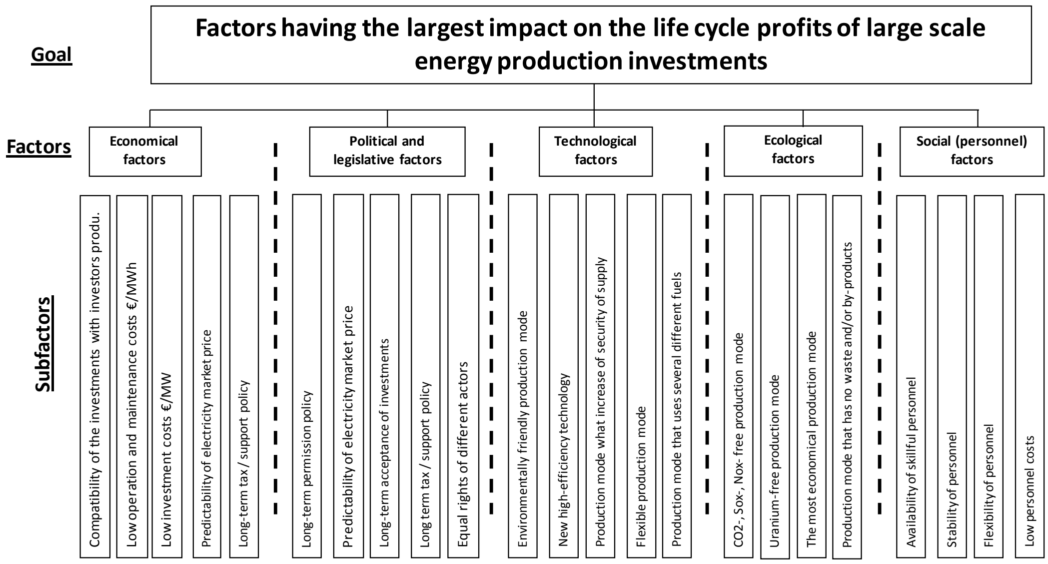


Figure 8. The hierarchy of the problem.

The research methodologies used were action analytical and constructive case research. The empirical data was collected by participant observation, including informal discussions, and by formal questionnaires. Responses to the research questionnaires were collected from nine significant decision-makers in the energy industry. The respondents represent a substantial proportion of the limited number of Finnish energy industry decision-makers. The size of the Finnish energy industry can be described by the yearly consumption of electric energy (87.3 TWh in 2008) and maximum power demand (13,287 MW in 2008) (STAT, 2009).

The validity of the results of the AHP model was tested by different statistical parameters and brainstorming. The parameters refer to calculated indices, their interpretation and interviews with experts, in which the research results and their validity were assessed. The validity of the research was strengthened by making use of the discussions (=brainstorming) with industry experts and colleagues on how well the questions measure the intended phenomena. During the brainstorming, the respondents also had the possibility to specify questionnaire data that had not been understood or had been insufficient. The results showed a high validity. The construction was tested by a weak market test, whose result was positive.

Knowing the special features of the local energy industry is a crucial element when defining the factors for the AHP model. The results showed that the main factors that have an effect on the energy sector investments' life cycle profits are both financial and political (see Figure 9).

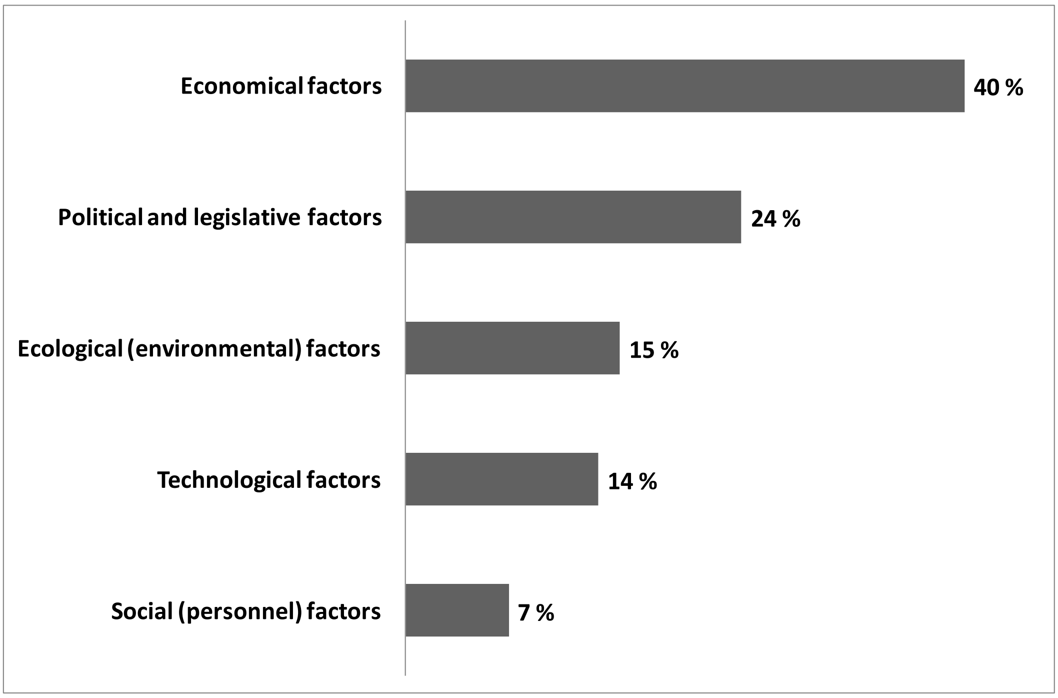


Figure 9. The weights of the factors that have the largest impact on the life cycle profits of large-scale energy production investments.

Companies need to use complicated analysis methods in relation to investments. The model results based on the AHP also give mainly quantitative information on the weight value of the factors.

The results showed that the main factors which have an effect on the energy sector investments' life cycle profits are both the economical and political and legislative factors. When analysed in more detail, the most significant subfactor among the economical factors was low operational and maintenance costs (€/MWh). Among the political and legislative subfactors, the most significant subfactor was the long-term tax/support policy. The results confirm the preconceptions of an industry which is going through constant change and in which practical challenges emerge from that change.

The results reveal that the economical and political and legislative factors make up more than 60% of the factors that affect decisions. The significance of the political and legislative factors, in particular, is a sign of the somewhat volatile situation of the investment environment. In a situation in which the ecological, technological and social effects gain emphasis, investors are able to compete more freely and aim at maximising economic profit in relation to the theoretically optimal situation.

The AHP model produces information on which factors are the most essential within the chosen framework and which are not. The information it produces is not absolute but relative to other factors.

The entire published article can be read in Appendix 1 of this dissertation.

3.2 Competitive Priorities of Investment Strategy: Case Wind Power

The goal of the research was to evaluate the major factors affecting the decision-making process of investments made in wind power, especially in Finland, from investors' and suppliers' point of views. The theoretical part of the research consists of the competitive priorities of investment strategies and the AHP model theories. The additional objective was to compare investors' opinions with suppliers' opinions with the help of the RAL model. In the study, a RAL model was constructed around the research problem (see Figure 10).

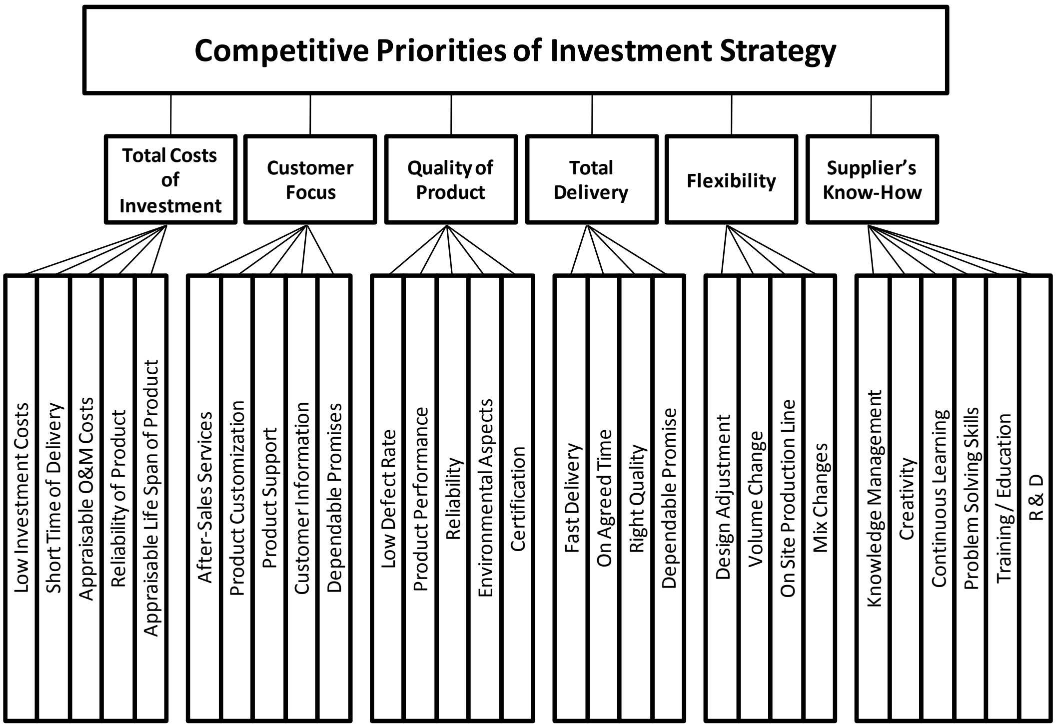


Figure 10. The responsiveness, agility and leanness model modified according to the AHP model.

The research methodologies used were action analytical and constructive case research. The empirical data was collected through the researcher's observations, including informal discussions, and by formal questionnaires. Responses to the research questionnaires were collected from 12 significant decision-makers in the energy industry. The size of the Finnish wind energy industry can be described by the installed wind power capacity, which was 142 MW by the end of 2008 (STAT, 2009). It is small compared to other European countries, and thus the number of wind power decision-makers is also limited in Finland. The results showed a high validity. The construction was tested by a weak market test, the result of which was positive. The test was carried out with the help of a repeat questionnaire given to and brainstorming discussions held with randomly chosen respondents. The purpose of these was to make sure that the respondents had understood the questions. The results of the repeat questionnaire and discussions supported the original research results.

The results showed that some investors' and suppliers' expectations of the competitive priorities of investment strategies' main factors differ from each other. The results suggested that from the point of view of both equipment suppliers and investors the quality of product is the most important factor when investment decisions on wind power are made. The second most important factor from the investors' point of view were the economic factors, whereas from the suppliers' point of view it was their expertise. In a strategic sense, this is significant for suppliers should understand the nature of an investment process from the customers' point of view. As for the main criteria, the respondents laid less emphasis on customer orientation and flexibility. This indicates that the wind power industry is experiencing a very product-oriented phase.

The data concerning individual subfactors suggest that there are also differences between the views of investors and equipment suppliers. However, the two respondent groups laid parallel emphasis on the subfactors of the quality of product, the most important factor.

As in the first publication, the AHP model produces information on which factors are the most essential within the chosen framework and which are not. The information it produces is not absolute but relative to other factors.

The process will also help suppliers to understand investors' expectations. The results showed that with the model, the competitive priorities of investment strategies are evaluated from both investors' and suppliers' point of view. The research findings give the equipment suppliers a possibility to reform their strategies according to the factors that wind power investors appreciate.

The entire published article can be read in Appendix 2 of this dissertation.

3.3 The Competitive Priorities of the Wind Power Investment

The target to cut CO2 emissions will increase investments in renewable energy production. The goal of this research was to analyse the decision-making process and the competitive priorities of investment strategies from wind power investors' point of view and to compare the findings with the opinions of wind power unit suppliers.

The wind power industry is growing rapidly in Europe and also in the entire world. The industrial size of the wind turbine market is still quite small, which opens doors for new suppliers.

The research method used was action research, in which the research is combined with existing theoretical knowledge, after which the empirical results are compared with existing theory. The external validity of the dynamic decision-making model developed in the research was tested with a weak market test including a questionnaire for specialists in the industry. The internal validity of the model was tested with another, alternative questionnaire addressed to part of the specialists, with the use of brainstorming and also with a comparison conducted using the inconsistency ratio (ICR or IR).

By calculating the relations between the suppliers' and investors' opinions with respect to each subfactor and calculating the absolute values of the importance rates of the investors' answers, six main factors were found. These six factors were:

- product performance,
- low defect rate,
- low investment costs,
- appraisable life span of product,
- reliability and
- reliability of product.

With respect to these subfactors, the differences in opinions between the suppliers and investors were the most significant. This means that suppliers should concentrate especially on these factors when they differentiate and aspire to achieve a competitive advantage in relation to their competitors.

On the other hand, the results revealed that the suppliers and investors agree on the importance of a great number of subfactors. This does not mean that these factors are not important; nevertheless, they cannot be used to gain a competitive advantage and exceed the investors' expectations.

The results of the analysis showed that some investors' and suppliers' expectations of the competitive priorities of wind power investments' main factors (two) and subfactors (six) differ from each other.

The entire published article can be read in Appendix 3 of this dissertation.

3.4 The Fast Strategy and Dynamic Decisions in Energy Industry

The purpose of this research was to focus on the investments made in the energy industry and on understanding the factors affecting those investments. The main goal of the research was to modify the fast strategy model in relation to the energy industry, which would provide support for energy sector investors and equipment suppliers to develop their enterprises. The subgoal was to analyse and gain an understanding of the decision-making processes of the energy industry and the competitive priorities of energy sector investments. Suppliers can utilise these findings when they construct and modify their strategies to be more sensitive.

In the research, factors were found that have an effect on investment decisions in the energy industry, and they were combined with existing leadership theories. The results were tested using energy production cost data from the Nordic countries and the United States. The usability of the results is limited by the fact that the research material is focused on the Nordic countries and the US and by restrictions related to the validity and reliability of the results. The results reveal the most important strategic factors and their effects on the production costs of the case energy production forms within the chosen framework.

The empirical data of the research was collected mainly through the researcher's observations as well as using earlier international researches. The purpose of this research was to deepen and expand the knowledge the earlier findings had provided.

In this research, an innovative and theoretically justified solution was created to answer a practical problem. The results were tested with a weak market test. The method of the study consisted of the constructive and action-oriented research approaches (Kasanen et al., 1993).

According to Doz and Kosonen (2007; 2008a; 2008b), companies should form their strategies in such a way that they are more flexible and that strategic decisions are agile. It should be possible to reform the strategies of a company continuously: weekly, daily or even hourly. The main components of strategic agility are strategic sensitivity, collective commitment and resource fluidity. According to Nieminen and Takala (2006), agility signifies a company's ability to act and battle in the dynamic state of continuous changes.

Strategic sensitivity means both sharpness of perception and intensity of awareness and attention. Resource fluidity refers to the internal capability to reconfigure business systems and redeploy resources rapidly. Collective commitment means the ability of the top team to make bold decisions fast.

Combining the results of this research with the existing theoretical framework, a model was created. Based on the earlier researches by Doz and Kosonen (2008a), Heackel (1999), Hamel et al. (2002) and Prahalad and Krishnan (2008), a process chart was created. The functionality of this process chart was tested by interviewing experts in the energy industry. In Figure 11, strategic agility is combined with the sense and response principle in order to generate a unique competitive advantage by utilising the added value gained through strategic alliances.

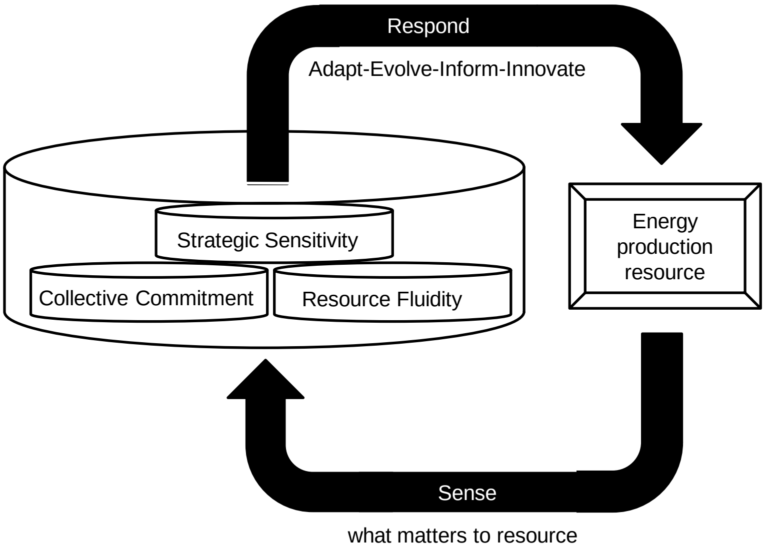


Figure 11. The dynamic strategy model for the energy sector.

According to Stephan H. Haeckel (1999), companies' business can be led in two alternative ways: following a “make and sell” or “sense and response” principle. The make and sell principle forms an internal, closed system, in which signals from the outside are not followed systematically. The sense and response principle utilises internal feedback and external signals (see Figure 11). Following the sense and response principle, companies look for influences from outside the company and act on them.

Utilising the best talents is an extremely important element of a company’s strategy. This is represented on the left side of Figure 11 as a unity of its own. Companies’ business operations must be able to adapt to the influences coming from outside. By utilising these influences and possibilities, companies can achieve a competitive advantage in relation to other actors in the industry if they succeed in strategic leadership.

The research findings give companies a possibility to reform their strategies to be more sensitive and at the same time create an individual, fast and dynamic decision model. The theoretical part of the research consisted of the different strategic methods. The results of this research provide help to enterprise leaders to develop their companies.

The process will help investors to understand the global context of the energy sector and offer a new, modified strategy model that can be used in the energy sector. The results showed that the fast strategy and dynamic decisions model for the energy industry can be created and tested mainly in a local context.

The entire published article can be read in Appendix 4 of this dissertation.

3.5 The Framework Factors Affecting the Acceptability of Wind Power

The global economic crisis affects the operating conditions of various business fields. The crisis has different kinds of impacts on different fields depending on their capital intensity and consumers' need for their products or services. The energy industry is special due to its capital intensity, long payback times for investments, regional political guidelines and the issue of general acceptability. In addition to the economic crisis, the need to cut down CO2 emissions because of the global warming has altered the operating environment of the field.

The goal of this research was to evaluate and analyse the factors that have an effect on the acceptability of wind power investments in decision-making situations. The research was restricted to apply mainly to the acceptability of wind power because in its case the technological options are similar worldwide and economical profitability depends on each country's legislative framework. The evaluation was made by examining the acceptance of wind power projects in countries where the level of installed wind power per surface area is relatively low compared to the EU level but which still produce a great number of wind power-related technological products (the employment effect).

Niiniluoto (1996) has used for example the following formula with six E's in assessing (technology assessment) information and communication technology (ICT) and the qualities of technologies:

Formula 1. Technology assessment.

Technology Assessment = (Efficiency × Economy × Ergonomics × Ecology × Esthetics × Ethics) + Social Consequences

The purpose of the formula is to determine what factors have to be taken into account when launching ICT products. Due to the nature of the formula, none of the E's can be left without consideration in order for the qualities of the technology to meet the needs of consumers.

From an ecological point of view, there are several models that can be used to estimate the consequences of a wind power project. These models are for example the IPAT (Holdren and Ehrlich, 1974) and ImPACT model (Waggoner and Ausubel, 2002). York et al. (2003) have researched the detailed differences between these two models.

By utilising these existing models, a specific innovative formula was constructed for the wind power industry. With the help of the formula, it is possible to assess the investment decision conditions of wind power construction. The formula consists of three factors: A = acceptance, E = economy and T = technology. In this research, it was referred to as the TEA model.

When considering energy production projects, the innovative TEA model indicates which technological (T) choices the investor can have an effect on. The economics (E) of the project are influenced by the price of energy, taxation and other economic and political guidelines. The acceptance (A) of the project is influenced by several outside factors, which were considered in this research.

In the context of the wind power industry, the TEA model can also be viewed as a formula:

Formula 2. The TEA model.

$$F(x) = T(x) \times E(x) \times A(x)$$
$$1 \geq T(x) \geq 0$$
$$1 \geq E(x) \geq 0$$
$$1 \geq A(x) \geq 0$$

If $F(x) > 0$, a lot of wind power construction is taking place in the area in question. If $F(x) = 0$, wind power construction is not possible in the area.

The equation means that building wind power is possible if it is technologically possible, it meets economic conditions and the project has general acceptance. Some of the factors can be left out of the equation on the grounds of obligations and entitlements based on local legislative decisions.

It can also be assumed that a certain wind power technology is available everywhere in the area in question. This means that the equation does not explain the differences between countries in building wind power. Therefore, the TEA model can be simplified to $F(x) \sim E(x) \times A(x)$.

This research was constructed around a qualitative research approach. In qualitative research, the goal is to understand the researched phenomenon. This means determining the meaning or purpose of the phenomenon and acquiring a deeper comprehension of the topic (Hirsjärvi and Huttunen, 1995). The design of this research was formulated in such a way as to meet the epistemological and ontological world of the research. Research epistemology addresses how we come to know reality by identifying particular practices. The ontological part was treated through observations made based on the research results. The empirical observations of the research reinforce its ontological relation to the real world.

In this research, empirical data was collected by formal questionnaires and by using the researcher's observations, including informal discussions. In the research, an innovative and theoretically justified solution was created to answer a practical problem. The results were tested with a weak market test. The approach was constructive (Kasanen et al., 1993).

The results showed that the support for wind power is high in EU countries that have relatively little wind power in relation to the country's surface area. Moreover, the support for wind power varies depending on whether there is a visual contact between a wind power plant and the respondent's property. The resistance is higher among those who presume that they would have a visual contact to the wind power project (see Figure 12).

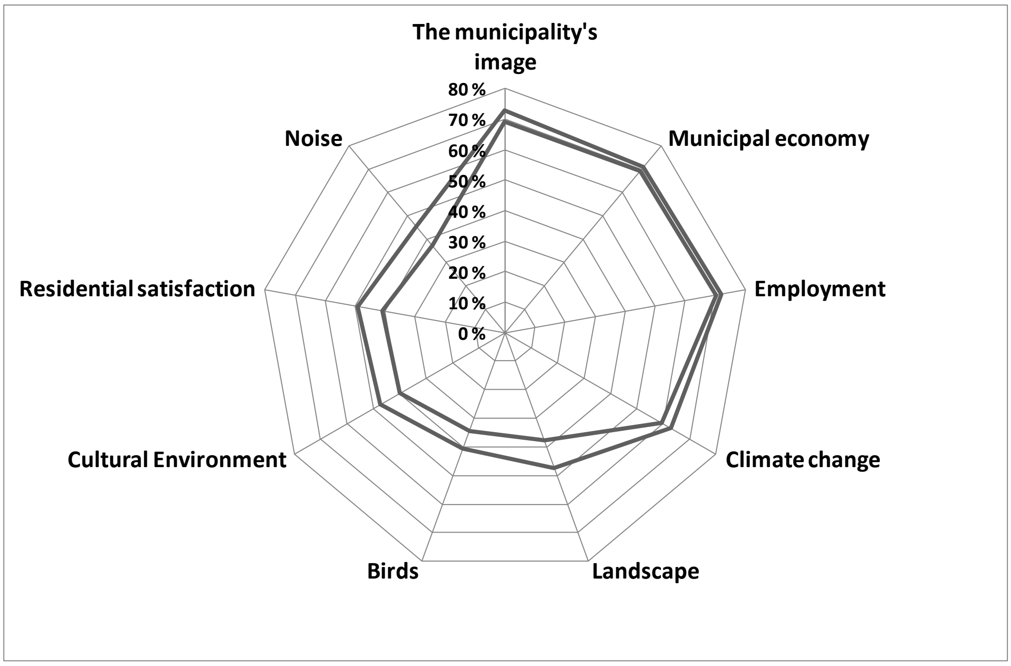


Figure 12. Differences of the acceptance factors of wind power between the respondent groups living nearby a project area who do not have a direct view to the project area (outer line) and those who have a direct view to the wind power plant (inner line).

The research results suggest that the general acceptance of building wind power is relatively high in Finland. The closer to the planned wind power plant people live, the more the acceptance rate decreases.

Hence, on the grounds of the research results, the original TEA model formula $F(x)=T(x) \times E(x) \times A(x)$ can be defined in such a way that factor $A(x)$ is dependent on the population rate in the area where the wind power construction is being planned. The effect of this factor can be reduced by legislative control.

Furthermore, economic means (factor $E(x)$) can be utilised in increasing wind power construction. This means for example a better ability to pay compensation for the people who will be harmed by the project.

The research results will help utility investors and country-/municipality-level decision-makers to understand the framework concerning building wind power, especially in Finland.

The entire published article can be read in Appendix 5 of this dissertation.

4 CONCLUSION

The objective of the research was to produce new scientific information concerning the factors having the largest impact on investment decisions in the energy industry. This information will be important for the scientific community, legislators, political policy-makers, energy investors, energy equipment suppliers, sponsors and other service providers. It is essential to understand that certain conditions must be met in order for the operators in the energy sector to be able to engage profitably in decades-long capital-intensive energy production plant projects.

The policy definitions made by the framework group that determines the future development of energy production are far-reaching. Typically, when plans for an investment in an energy production plant are started, it will take years, sometimes a decade, before the plant will start to produce energy. Therefore, it is important that the interest groups that shape the related framework use scientific data and recognise the complex issues related to energy production.

This research will have practical benefit since the information it generates is public, the accuracy of the information has been tested and generality evaluated, the articles that make up the research have been presented at international conferences and published in scientific journals and thus the autonomy of the research has also been assessed by international experts.

The research questions of this study were focused specifically on the Finnish energy industry. They were divided into two parts: those that concerned the energy industry in general and those concerning wind power as a special topic. The first research question “what kinds of factors have the largest impact on the life cycle profits of large-scale energy production investments?” was answered in the first publication. Based on the study, out of five different factors, the importance of the economic and political and legislative factors combined was more than 60%.

The second research question “how can the theories of agile strategic management be combined with the competitive priorities affecting energy production investment decisions?”, concerning the energy industry in general, was responded in the fourth publication. With the help of the model created as part of the study, existing theories were synthesised, taking into account the special characteristics of the energy industry.

The third research question “what are the differences of the major factors of decision-making processes affecting investments from the investors’ and suppliers' point of view?", which focused on wind power, was answered in the second and third publication. The study suggested that the views of investors and suppliers differed from one another to some degree. In the research, six factors were identified as the most significant (product performance, low defect rate, low investment costs, appraisable life span of product, reliability and reliability of product), in relation to which investors' and suppliers' views differ from one another. As a result of a thorough analysis based on the research question, a tripartite model was formulated, whose elements summarise the competitive priorities related to wind power investments within the research framework (see Figure 13).

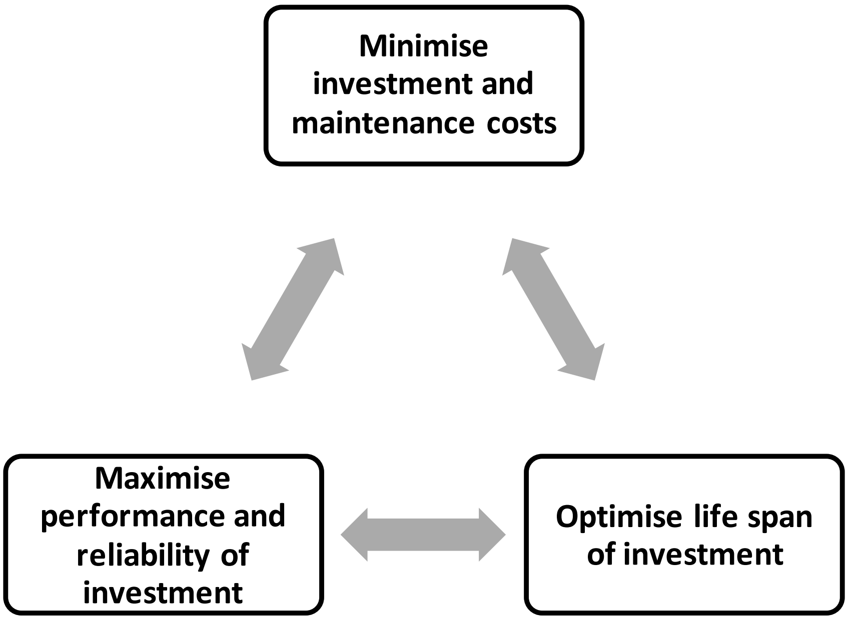


Figure 13. The competitive priorities related to wind power investments between investors and equipment suppliers at the moment of investment.

The fourth research question made the research framework, whose emphasis was on investment decisions, more comprehensive. The purpose of the fourth research question was to complement the field of research and identify also such factors within the investment decision framework that investors are unable to directly influence. Like the third research question, the fourth "what kind of relation do the framework factors affecting the acceptability of investment projects have to the other decision-making factors affecting the investment preconditions?" also focused on wind power. The TEA model (technology, economy and acceptance) generated as part of the research concretised the research area. A wind power project can only be implemented if the product of the factors of the TEA model multiplied is sufficient. The research concentrated particularly on the acceptance factor A(x) and its relation to the economy factor E(x).

In the research, the essential factors, i.e. the acceptance factors, were analysed on three different levels: by examining the general acceptance of wind power, the acceptance in areas where wind power parks are planned and the attitude of those who have a direct view to the planned park. The closer to the planned plant people live, the more the positive attitudes decrease.

The results of this research will help investors and decision-makers to understand how the operational environment affects energy investments that are important for the society and also the factors that have an effect on the growth of renewable energy forms.

4.1 Synthesis

The results of the individual research publications have been examined separately in the sections concerning the publications. The purpose of this section is to examine the dissertation as a whole together with its theoretical and practical implications. Considering the research as a whole, a framework was formed with the help of the separate publications within which different competitive priorities affecting investments in energy production were identified. Depending on the nature of the competitive priority, it provides investors, equipment suppliers or political decision-makers information on the relevant and irrelevant factors affecting investment processes. The research succeeded in separating the most essential from a great number of factors.

Figure 2 describes the connections between the individual publications within a macroeconomic framework and from the perspective of the energy industry in general and wind power in particular. When investment decisions are made or legislative guidance is implemented, the entire field of affecting factors should be considered instead of optimising a single factor. This is especially true from a legislative point of view. This research indicates that legislatively it does not suffice that a great number of conditions related to investments in energy production plants have been taken into account but all the factors as a whole should be balanced.

The research suggests that economic and political factors have the largest impact when making decisions concerning large-scale energy production investments, and those theories of strategic management can be combined with the competitive priorities affecting energy production investment decisions. Regarding wind power, six different competitive priorities were identified, in relation to which investors' and equipment suppliers' views differ the most. When decisions are made concerning the implementation of a wind power project, there are three factors that must be correctly balanced: the acceptability of the project, economy and technology. Without these, wind power projects cannot be launched since the preconditions for implementing investments are not met.

The research provides a comprehensive analysis of the factors that affect investment decisions in the energy industry, including an examination of wind power as an example of one form of energy production. In order to reliably evaluate the investment preconditions concerning different energy production forms, it is first necessary to understand the background affecting the industry as a whole, after which the different energy production forms can be compared. The information produced by this research is valuable because it describes the background affecting the different forms of energy production. Partial and separate examinations of individual energy production forms do not necessarily offer a reliable image of how they operate in different real-world contexts.

As for the theoretical implications, the research produces scientific information on investment decisions, which has been tested particularly with respect to wind power. As a subject for future research, this research could be expanded to include other forms of energy production by broadening the theoretical framework. From a geographical perspective, the research describes the circumstances in Finland as well as the other Nordic countries. The information produced by the research is available for decision-makers in the research area.

As for strategic leadership, the research identified ways to manage companies using agile methods, in which management is based on signals from the outside of the company. This is especially significant since, as the findings of the individual publications suggest, the fulfilment of investment decision preconditions depends on several different factors. These factors cannot be entirely controlled by the companies themselves because they are determined by, for example, regional, national or continental political goals and commitments.

The individual publications reveal that legislative guidance plays a significant role. Through decisions, legislators can influence investment preconditions, which in turn have an effect on the competitive edge of the nation in relation to other areas or countries.

In the research area, it has been years since large-scale investments in energy production capacity have been made, excluding single investments in existing, aging capacity. The energy production plants in the main research area are approaching the end of their life cycle, which increases the importance of new investments. The research results indicate that investments are made to a significant degree only if the exceptional investment environment is such that the most important factors from the investors' point of view are sufficiently stable and predictable. In the case of wind power, these factors are to a great extent related to the political and legislative framework and the economic conditions.

4.2 Validity and Reliability of the Study

There is an ongoing debate on how to estimate reliability and validity in qualitative research (see for example Shenton, 2004). The validity and reliability of this research have been tested in various ways. The researcher is employed in the energy industry and thus has the opportunity to examine the validity and reliability of the research results in his everyday work.

Validity, with regard to measurement, means the congruence between an operational definition and the concept it is supposed to measure (Singleton and Straits, 2004). High validity means a good convergence of various findings. Often the challenge in determining validity is the uncertainty as to the "correct" value or response. The assessment of validity is inherently more problematic than the assessment of reliability. In qualitative empirical research, tests of validity are most often used to examine construct validity, internal validity and external validity (Yin, 2009).

The construct validity of the research depends on how well the selected measures reflect the phenomenon under investigation. In this study, the phenomena studied were the facilitators and competitive priorities of energy production, with a special focus on wind power investments in Finland. For this purpose, an analysis framework was developed. One objective of the framework was to provide common tools and methods for analysing the energy sector specialists' answers. The framework determined the methods used in the empirical part of each publication. Here, the methods mean the indicators, as described by Yin (2009) that reflect and describe the phenomenon dealt with in each publication. These methods were developed based on earlier research as well as on experience of the industry. As described in the empirical part of this study, the developed methods were used in a similar way in the analysis of the specialists' answers in each publication.

Using multiple sources of evidence has increased the construct validity of the case studies. The analyses were based on formal interview forms, interviews and observations. This process is described in more detail in section 2.3 titled "Data Collection and Analysis". Using multiple sources of evidence also supports the triangulation of data sources, which means comparing and cross-checking the consistency of information derived at different times and by different means (Patton, 1990). In this study, this was done by using several sources of evidence and mathematical methods in the publications.

Internal validity measures the logic between observations and inferences. The internal validity of the research was strengthened by following Langley's (1999) and Van de Ven's (2007) recommendations, in accordance to which the discussions with experts were tested as to how well the questions used measured the phenomenon in question. While analysing the results, internal validity was further increased by a random sample check carried out afterwards, the purpose of which was to ensure that the respondents had understood the phrasing of the questions.

The respondents of the research questionnaires replied to all the questions included in the questionnaires. The questionnaires were quantitative, not enabling free replies, and the experts' opinions were collected separately through interviews and working in small groups.

External validity deals with the generalisability of the research findings. This study was limited to a selected field of business, the energy production industry in Finland. This may affect the possibilities of expanding the results to other countries or business sectors. However, focusing on the energy production industry in Finland was seen as strength of the study because it provided the opportunity of considering the unique requirements of this industry. The research results could be extended outside Finland but that would require taking into consideration the changes in the framework factors, legislation, support or tax systems etc. that characterise the energy industry (cf. Introduction). On the other hand, it would be possible for legislators and equipment suppliers to apply the results, taking into account the geographical focus of the study. As for other branches of industry, the results are not directly applicable. In such cases, it would be necessary to consider the special characteristics of the industry when determining the details of the developed models.

Reliability is often measured by how well another researcher is able to repeat the results with the same data (Yin, 2009). Reliable findings are consistent and repeatable (Singleton and Straits, 2004). The reliability of this research was strengthened by measuring the same phenomenon using several variables. Research data was collected from experts in the industry through interviews, working in small groups and formal questionnaires. Special attention was paid to the issues that were the most essential to the study, which enabled the production of new information that would contribute to the scientific discussion. The data was processed using common and publicly available computer software.

A potential weakness of the study method is the lack of replicability: the results are to some extent dependent on the researcher. However, it should be noted that the emphasis on replicability is on doing the same study again rather than replicating the results in another study which would use the same methods as this study (Yin, 2009). Furthermore, the research includes data collected from several experts, and the results have been analysed together with experts in the field.

According to Patton (1990), the credibility of the researcher is one of the three inquiry elements that affect the credibility of a qualitative inquiry. Patton (1990) states that the researcher should report any personal or professional information that may have affected the data collection, analysis or interpretation. The author of this research works in an energy company, and this work involves investment decisions and strategic planning. In addition, the researcher also manages separate companies, which aim at investing in, building and producing energy from wind power.

The third inquiry element that affects the credibility of a qualitative inquiry is the philosophical belief in the phenomenological paradigm (Patton, 1990). According to Patton (1990), one of the beliefs that affect how people react to qualitative data is how people think about the idea of truth. Instead of claiming that the researcher's findings are the ultimate truth, Patton (1990) suggests describing the pattern of data as the researcher's perspective based on his/her analysis and letting the reader judge the perspective using his/her own perspectives. Accordingly, in this study the patterns of the publications' results are described on a fairly detailed level, which provides one perspective to the research area.

4.3 Relevancy and Practicality of the Study

The relevancy and practicality of the study have been assessed by means of the researcher's analysis and with the help of experts in the field. The results of this research provide a scientific basis for the evaluation of the success factors related to energy production projects as well as for the assessment of the current, diverse scientific and political discussions on the energy industry. The research shows that the energy industry is very complex due to the capital-intensive investments with long payback times and that the changing operating environment and the various regulatory methods it gives rise to create a situation for the operators in the industry in which there is a risk of generating generally unoptimal solutions through partial optimisations.

In this research, relevancy refers to the currentness and importance of the research subject and the results. The practicality of the research and its results means how close or applicable they are to practice.

When the research topic and the results were presented to an energy industry expert, chief executive officer and president of several energy companies, he made the following remark: “The topic of the research and the data it has produced will help us to develop the operations of our company and also provide us with a better opportunity to analyse material related to investment decisions. The research benefits the energy industry as a whole. The research results are up to date.”

When the research results were presented to the country manager of an international company supplying services to the energy industry (e.g. wind power investors), the following comment was made: “The results of the research will help service providers and equipment suppliers to get an idea of what their clients, representatives of energy companies, value and give importance to at the moment of making an investment decision.”

One expert and research director, docent and Doctor of Philosophy, who has evaluated the effects of energy production projects on the surrounding society, assessed the relevancy and practicality of the research by stating that the research deepens scientific knowledge and at the same time offers new, practical information to the experts in the field. Its results help to understand how complex and interdependent the factors that affect energy sector investment decisions are.

From the point of view of the researcher, the choice of the research topic and formulation of the research questions were based on a real practical problem, which needed to be solved with the help of scientific methods. The information produced by the research is currently being utilised in the companies where the researcher works. In practice, this information is used in the analysis and preparation of investment decision situations. The research results also provide a description of the energy industry for the use of equipment suppliers and legislators.

4.4 Study Limitations and Future Research

The information the research has produced responds to the research questions within the framework of the research. The framework was based on the Finnish circumstances, the Nordic electricity market and country-specific legislation. When considering areas of subsequent research, it is important to take into account that if the framework used in this research is altered, the methods and results produced by this research will also have to be reconsidered.

Regional legislative frameworks and the related support, tax, and permission systems control energy production to such a degree that it is not possible to apply the methods used in the case of one country to another country without carrying out a detailed background research.

The framework of the research could be extended in various ways for future research. For example, extending the study to other continents would shed light on the most significant competitive priorities affecting energy industry investment decisions in different electricity systems. The information produced by such a study would be very valuable for globally operating energy production companies and particularly equipment suppliers. On the other hand, energy companies usually operate locally, which renders the type of information produced by this research important.

The special issue in this research was wind power, which could be replaced by another form of energy production in order to investigate the relation between the competitive priorities related to that energy production form. The results could be compared with those concerning wind power or examined separately. For example, it would be interesting to compare the differences between wind power and nuclear power with respect to the competitive priorities discovered through research. Or, to study how energy from wind power differs from energy produced from coal, considering the current climate-political situation. Both nuclear and coal power generate significantly more employment locally compared to wind power. This may have an impact on the NIMBY (Not In My Back Yard) phenomenon, even though this research suggests that, at the time of the research, wind power is generally regarded as a more suitable form of energy production (see Appendix 5).

Further research could also be conducted to examine the development of the data produced by this study, its use in practice and the gained results in time. Such research could be carried out using the framework of this study or an extended version of it.

References

Álvarez-Farizo, B. & Hanley, N. (2002). Using conjoint analysis to quantify public preferences over the environmental impacts of wind farms. An example from Spain. *Energy Policy* 30:2, 107–116.

Arbnor, I. & Bjerke, B. (1997). *Methodology for Creating Business Knowledge*. London: Sage Publications.

Bergmann, A., Hanley, N. & Wright, R. (2006). Valuing the attributes of renewable energy investments. *Energy Policy* 34, 1004–1014.

Blanco, M. (2009). The economics of wind energy. *Renewable and Sustainable Energy Reviews* 13, 1372–1382.

Blanco, M. & Rodrigues, G. (2008). Can the future EU ETS support wind energy investments? *Energy Policy* 36, 1509–1520.

Bosetti, V., Carraro, C., Massetti, E. & Tavoni, M. (2007). *Optimal Energy Investment and R&D Strategies to Stabilise Greenhouse Gas Atmospheric Concentrations*. Fondazione Eni Enrico Mattei Working Papers 154.

Bryman, A. (1988). *Quantity and Quality in Social Research*. London, Boston: Unwin Hyman Publications.

COM. (2007a). *Commission of the European Communities, Communication from the Commission to the European Council and the European Parliament, An Energy Policy for Europe*. Brussels: Commission of the European Communities.

COM. (2007b). *Commission of the European Communities, Communication from the Commission to the European Council and the European Parliament, Renewable Energy Road Map Renewable Energies in the 21st Century: Building a More Sustainable Future*. Brussels: Commission of the European Communities.

Creswell, J. (2003). *Research Design. Qualitative, Quantitative, and Mixed Methods Approaches*. CA: Sage, Thousand Oaks.

Doz, Y. & Kosonen, M. (2007). The new deal at the top. *Harvard Business Review* 6, 98–104.

Doz, Y. & Kosonen, M. (2008a). *Fast Strategy: How Strategic Agility Will Help You Stay Ahead of the Game*. London: Wharton School Publishing.

Doz, Y. & Kosonen, M. (2008b). How agile is your strategy process? *Strategy Magazine* 15, 6–10.

Eisenhardt, K. (1989). Building theories from case study research. *The Academy of Management Review* 14:4, 532–550.

Eskola, J. & Suoranta, J. (2000). *Johdatus laadulliseen tutkimukseen*. (4th edition). Tampere: Vastapaino (in Finnish).

EWEA. (2009). *Pure Power 2009 - Wind Energy Targets for 2020 and 2030*. A report by the European Wind Energy Association – 2009 update.

Gipe, P. (1995). *Wind Energy Comes of Age*. New York: John Wiley & Sons, Inc.

Haeckel, S. (1999). *Adaptive Enterprise, Creating and Leading Sense-and-Respond Organization*. Boston: Harvard Business School Press.

Hamel, G., Doz, Y. & Prahalad, C. (2002). *Collaborate with Your Competitors and Win*. Boston: Harvard Business Review on Strategy Alliances. Harvard Business School Publishing Corporation.

Hanley, N. & Nevin, C. (1999). Appraising renewable energy developments in remote communities: the case of the North Assynt Estate, Scotland. *Energy Policy* 27, 527–547.

Hirsjärvi, S. & Huttunen, J. (1995). *Johdatus kasvatustieteeseen*. (4th edition). Porvoo, Helsinki, Juva: WSOY (in Finnish).

Holdren, J. & Ehrlich, P. (1974). Human population and the global environment. *American Scientist*, 62, 282–292.

Holttinen, H. (2004). *The Impact of Large Scale Wind Power Production on the Nordic Electricity System*. Espoo: VTT Processes, Doctoral dissertation, VTT Publications: 554.

Holttinen, H. (2008). Estimating the impacts of wind on power systems. *Modern Power Systems* 28:5, 49–52.

IPCC. (2007). *Climate Change 2007: Synthesis Report*. An Assessment of the Intergovernmental Panel on Climate Change.

Jylhä, R. (2006). *Sähkönhuollosta sähkömarkkinoihin*. Vaasa: Acta Wasaensia No 154, Department of Business Law, Doctoral dissertation, University of Vaasa (in Finnish).

Kara, M., Syria, S., Lehtilä, A., Helynen, S., Kekkonen, V., Ruska, M. & Forsström J. (2008). The impacts of EU CO_2 emissions trading on electricity markets and electricity consumers in Finland. *Energy Economics* 30:2, 193–211.

Kasanen, E., Lukka, K. & Siitonen, A. (1993). The constructive approach in management accounting research. *Journal of Management Accounting Research* 5, 241–264.

Kemmis, S. & Wilkinson, M. (1998). *Participatory Action Research and the Study of Practice*. Action research in practice: partnerships for social justice in education. London: Routledge.

Kovács, G. & Spens, K. (2005). Abductive reasoning in logistics research. *International Journal of Physical Distribution & Logistics Management* 35:2, 132–144.

Kunnas, P. (2009). *Systematic Management of Emerging Strategic Issues: Organisational Attention Allocation and Strategic Issue Management System Performance.* Espoo: Department of Industrial Engineering and Management, Doctoral dissertation, Helsinki University of Technology.

Laakso, T., Makkonen, L. & Holttinen, H. (2006). Climate change impact on icing of large wind turbines. *European Conference on Impacts of Climate Change on Renewable Energy Sources*.

Langley, A. (1999). Strategies for theorizing from process data. *Academy of Management Review* 24, 691–710.

Lawrence, J. & Pasternack, B. (2002). *Applied Management Science: Modeling, Spreadsheet Analysis, and Communication for Decision Making*. New York: John Wiley & Sons Inc.

Lee, A., Chen, H. & Kang, H. (2009). Multi-criteria decision making on strategic selection of wind farms. *Renewable Energy* 34, 120–126.

Levin, M. & Leplin, J. (1984). *What Kind of Explanation is Truth?* Berkeley: Scientific Realism, University of California Press.

Lewis, J. & Wiser, R. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. *Energy Policy* 35: 3, 1844–1857.

Lu, X., McElroy, M. & Kiviluoma, J. (2009). Global potential for wind-generated electricity. *Proceedings of the National Academy of Sciences of the United States of America* 106: 27, 10933–10938.

Mackenzie, N. & Knipe, S. (2006). Research dilemmas: Paradigms, methods and methodology. *Issues in Educational Research* 16:1, 193–205.

Meibom, P., Kiviluoma, J., Barth, R., Brand, H., Weber, C. & Larsen, H. (2007). Value of electric heat boilers and heat pumps for wind power integration. *Wind Energy* 10:4, 321–337.

Milligan, M., Porter, K., DeMeo, E., Denholm, P., Holttinen, H., Kirby, B., Miller, N., Mills, A., O'Malley, M., Schuerger, M. & Soder, L. (2009). Wind power myths debunked. *Power and Energy Magazine* 7:6, 89–99.

Moilanen, M. (2009). *Institutions, Technology and Markets in Industry Evolution: Causal and Evolutionary Mechanisms in a Regulated Industry*. Espoo: Department of Industrial Engineering and Management, Doctoral dissertation, Helsinki University of Technology.

Moran, D. & Sherrington, C. (2007). An economic assessment of wind farm power generation in Scotland including externalities. *Power Policy* 35, 2811–2825.

Neilimo, K. & Näsi, J. (1980). *Nomoteettinen tutkimusote ja suomalainen yrityksen taloustiede, tutkimus positivismin soveltamisessa*. Tampere: University of Tampere, School of Business Administration publications, series A 2: 12 (in Finnish).

Nieminen, P. & Takala, J. (2006). Achieving better on-time-delivery performance with the help of internal dependencies in the production. *International Journal of Management and Enterprise Development* 3, 181–190.

Niiniluoto, I. (1996). Teknologiapolitiikka, arvot ja kansalaiset. *Tiedepolitiikka* 4, 37–44 (in Finnish).

Ojanen, E. (1999). Filosofian sanakirja. *Taskufacta-sarja*. Porvoo, Helsinki, Juva: WSOY (in Finnish).

Olkkonen, T. (1993). *Johdatus teollisuustalouden tutkimustyöhön*. Espoo: Otaniemi, Teknillinen korkeakoulu, teollisuustalous ja työpsykologia. Report No. 152 (in Finnish).

Patton, M. (1990). *Qualitative Evaluation and Research Methods*. (2nd edition). Newbury Park: SAGE Publications.

Prahalad, C. & Krishnan, M. (2008). *The New Age of Innovation. Driving Co-Created Value Through Global Networks*. New York: McGraw Hill.

PricewaterhouseCoopers (2009). *Low Carbon Economy Index*. United Kingdom.

Rangone, A. (1996). An analytical hierarchy process framework for comparing the overall performance of manufacturing department. *International Journal of Operations & Production Management* 16: 8, 104–119.

Redlinger, R., Andersen, P. & Morthorst, P. (2002). *Wind Energy in the 21st Century. Economics, Policy, Technology, and the Changing Electricity Industry*. New York: Palgrave.

Saaty, T. (1977). A scaling method for priorities in hierarchical structures. *Journal of Mathematical Psychology* 15, 234–281.

Saaty, T. (1980). *The Analytic Hierarchy Process: Planning, Priority, Resource Allocation.* New York: McGraw-Hill.

Saaty, T. (1999). *Decision Making for Leaders*. (3rd edition). Pittsburgh: RWS Publications.

Saaty, T. & Bennett, J. (1977). A theory of analytical hierarchies applied to political candidacy. *Behavioral Science* 22, 237–245.

Saaty, T. & Mariano, R. (1979). Rationing energy to industries: priorities and input-output dependence. *Energy System Policy* 3:1, 85–111.

Salo, A. & Hämäläinen, R. (1997). On the measurement of preferences in the analytic hierarchy process. *Journal of Multi-Criteria Decision Analysis* 6, 309–343.

Shell. (2009). *Shell Energy Scenarios to 2050*. (4th edition). The Hague: VMS.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information* 22, 63–75.

Singleton, R. A. & Straits, B. C. (2004). *Approaches to Social Research*. (4th edition). New York: Oxford University Press.

STAT. (2009). *Statistical Yearbook of Finland 2009*. Helsinki: Statistics Finland.

Steinbuks, J., Meshreky, A. & Neuhoff, K. (2009). *The Effect of Energy Prices on Operation and Investment in OECD Countries: Evidence from the Vintage Capital Model*. Cambridge: Cambridge Working Paper in Economics 0933.

Strbac, G., Shakoor, A., Black, M. & Bopp, T. (2007). Impact of wind generation and development of the UK electricity systems. *Electric Power Systems Research* 77, 1214–1227.

Söder, L., Hofmann, L., Orths, A., Holttinen, H., Wan, Y. & Tuohy, A. (2007). Experience from wind integration in some high penetration areas. *Energy Conversion* 22:1, 4–12.

Söder, L. & Holttinen, H. (2008). On methodology for modelling wind power impact on power systems. *International Journal of Global Energy Issues* 29:1–2, 181–198.

Takala, J. (2002). Analysing and synthesising multifocused manufacturing strategies by analytical hierarchy process. *International Journal of Manufacturing Technology and Management* 4, 345–355.

Takala, J. & Toshev, R. (2007). Analyzing competitiveness of manufacturing and service operations – global benchmarking of cases from Slovenia and Slovakia. *Proceedings of the Management International Conference 2007*.

Finnish Government. (2008). *Pitkän aikavälin ilmasto- ja energiastrategia*. Report to the Parliament on the long-term climate and energy strategy (in Finnish).

Van de Ven, A. H. (2007). *Engaged Scholarship*. Oxford: Oxford University Press.

Varho, V. (2007). *Calm or Storm? – Wind Power Actors' Perceptions of Finnish Wind Power and Its Future*. Helsinki: Department of Biological and Environmental Sciences, Doctoral dissertation, University of Helsinki.

VTT. (2009). *Energy Visions 2050*. Several authors. Espoo: Edita Publishing Ltd.

Waggoner, P. & Ausubel, J. (2002). A framework for sustainability science: a renovated IPAT identity. *Proceedings of the National Academy of Sciences* 99, 7860–7865.

Worrall, J. (1998). *Philosophy of Science*. Routledge Encyclopaedia of Philosophy. London: Routledge.

Yin, R. K. (2009). *Case Study Research: Design and Methods*. (4th edition). California: Sage Publications Inc.

York, R., Rosa, E. & Dietz, T. (2003). STIRPAT, IPAT and ImPACT: analytic tools for unpacking the driving forces of environmental impacts. *Ecological Economics* 46, 351–365.

Int. J. Nuclear Governance, Economy and Ecology, Vol. 2, No. 3, 2009 281

The model based on the analytic hierarchy process for dynamic decision making in the energy industry: a case analysis of investment energy production in Finland

Tomi Mäkipelto* and Josu Takala

Department of Production
University of Vaasa
P.O. Box 700, 65101 Vaasa, Finland
E-mail: tomi.makipelto@uwasa.fi
E-mail: jot@uwasa.fi
*Corresponding author

Abstract: The goal of the research was to find out, define and evaluate the major factors of the decision-making process in the energy industry, especially in Finland. The theoretical part of the current research consists of energy system models and Analytic Hierarchy Process (AHP) model theories. The additional objective was to determine the characteristics of the Finnish energy industry.

The research methodologies which were used were an action analytical and a constructive case research. The empirical data were collected using participant observation (including informal discussions) and formal questionnaires. The validity of the results of the AHP was tested by different statistical parameters and brainstorming. The results showed a high validity. The construction was tested by a weak market test, whose result was positive.

The results showed that the main factors, which have an effect on the energy sector investments' life cycle profits, are both the financial and political factors. In the future, it is obvious that certain changes are taking place in the industry and, therefore, the dynamic multicriteria decision-making process will help make the decisions. The results clearly showed that with the model, the important factors in the investment decision-making process are found.

Keywords: multicriteria decision-making; analytic hierarchy process; AHP; Finnish energy sector.

Reference to this paper should be made as follows: Mäkipelto, T. and Takala, J. (2009) 'The model based on the analytic hierarchy process for dynamic decision making in the energy industry: a case analysis of investment energy production in Finland', *Int. J. Nuclear Governance, Economy and Ecology*, Vol. 2, No. 3, pp.281–295.

Biographical notes: Tomi Mäkipelto is a postgraduate student in the Faculty of Technology of the University of Vaasa in Finland. He holds an MSc in Technology (major in Industrial Management) from the Tampere University of Technology (2005). His field of interest is the investment decision process in the energy industry. His work experience background includes being a Managing Director in Rajakiiri Oy (investment company, focus on investment in windfarms in Finland) (2007–present), Vice President in Etelä-Pohjanmaan Voima Oy (2008–present), a Development Manager in Etelä-Pohjanmaan Voima Oy (2006–2008) and an Expert (Business Economics) in Etelä-Pohjanmaan Voima Oy (2005–2006).

Josu Takala is a Professor of Industrial Management and the Vice Dean of the Faculty of Technology of the University of Vaasa, Finland. His field of interest is mainly technology management in the competitive strategies of private and public organisations in manufacturing networks by using the generic fields of quality management, (technology) strategy, new product development, production management, logistics and environmental management. He is a member of the IEEE and the Chairman of the International Society of Productivity and Quality Research (ISPQR). He has published over 200 scientific articles.

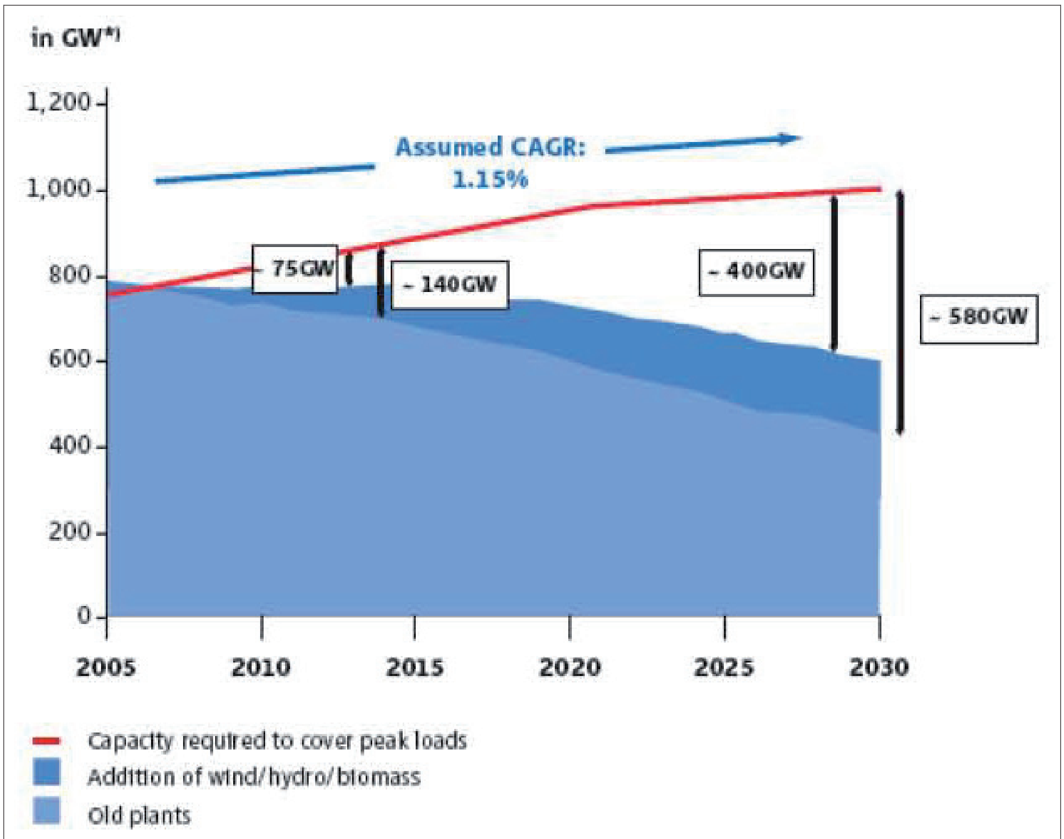
1 Introduction

There have been and there still are a lot of changes taking place in the Finnish energy industry. This is due to the changes in the national and international operations models. The energy industry in Finland has traditionally been restricted by the national legislation, but recently, several municipality-owned companies have denationalised their operations, which has led to a more market economy-like environment on the field. Until this electricity market change in the energy industry, the companies have had the possibility of operating partly without taking the rules of the market economy into consideration because it has been possible to transfer the operating cost directly or indirectly to consumer prices (Jylhä, 2006).

Finland and other Nordic countries have been the pioneers of international electricity markets. Finland was among the first to open up electricity markets for competition in the mid-1990s. Recently, the industry has started to internationalise also in Europe due to the deregulation of the market. In the last decade, the investments have almost stopped for several reasons and, at the same time, the electricity production capacity has become obsolete in Finland as well as in other Nordic countries. This has led to a problematic situation where Finland, who is depending on the imports of Russia, Estonia, Sweden and Norway, has to make some significant investments on the energy industry in the near future. The European Union has set a goal for all of its member countries to invest 1,000 billion euros to meet the electricity demand and replace the ageing electricity production infrastructure in the next 20 years (COM, 2006). Figure 1 shows that the absolute size of the power plant portfolio in Europe has to grow 1.15% per year during 2005–2030 to be able to meet the growing demand for electricity and, at the same time, replace the electricity production capacity in challenging conditions.

The Kyoto Protocol is an agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). The Kyoto Protocol will cause big changes for the energy industry. The first trading period of the European Union Emission Trading Scheme (EU ETS) provided a soft transition to the 2008–2012 period when the EU is committed by the Kyoto Protocol to reduce emissions. One of the main goals of the EU ETS is to change power and industry production from technologies with high CO2 emissions to technologies with low CO2 emissions. One of the most discussed drawbacks of the EU ETS is its impact on electricity prices. This has a large impact on energy-intensive industries. Typically, power-intensive industries (for example, the steel and pulp and paper industries) sell their products on the world market and complete with producers outside Europe, who are not subject to the EU ETS or similar measures and who have not experienced the corresponding power price increases (Rydén and Fritz, 2006).

Figure 1 The development of the European power plant portfolio from 2005 to 2030 (see online version for colours)

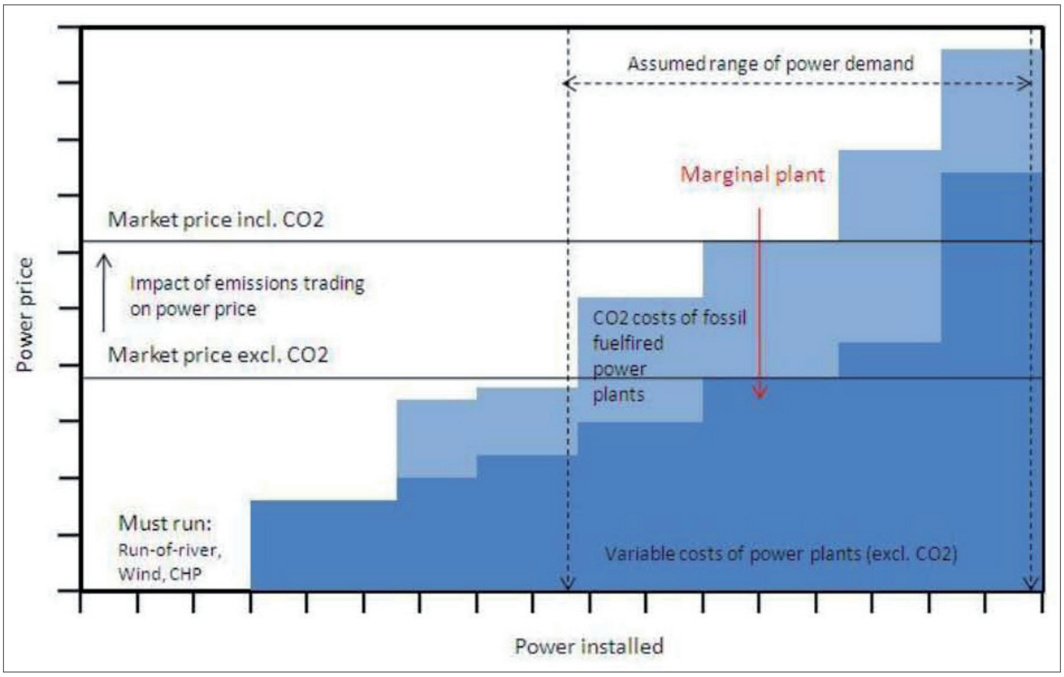


Note: *) EU 27, Norway, Switzerland.
Source: RWE (2007)

The new decade in the Nordic energy markets will 'turn a new page' for the energy industry. The EU ETS and other policy instruments have changed the Nordic energy markets and the operating environment of the Nordic companies. It is clear that electricity prices rise as EU emission Allowance (EUA) prices do due to the increased marginal costs of electricity production from fossil fuels (Rydén and Fritz, 2006). At the same time, the Nordic energy markets are expanding both to the east and south, which will further influence the Nordic electricity markets.

According to the specialists in the European energy industry, the energy field in Europe will face the biggest changing period for decades (The Big Leap, 2006). This will also have an impact on the Nordic energy industry. The Nordic energy markets have been changing and they will continue changing. New political infrastructures will radically change the cost structure of the industry. Figure 2 shows the theoretical power pricing of the Nordic or European electricity industry with and without emissions trading.

Figure 2 The theoretical power pricing of the electricity industry with and without emissions trading (see online version for colours)



As can be seen in Figure 2, the earning conditions of companies have been enormously changed by the impacts of emission trading. This is because we are dealing with an industry in which the profitability of the production facility is based on a very long payback period. In practice, this means that the life cycle profits have decreased in electricity production capacity, which utilises already invested fossil production forms. Emissions trading and other political regulation mechanisms have a large-scale impact on the profitability of individual production units. The marginal costs of the units utilising fossil fuels have even doubled because of the EU ETS. Analysing and making investment decisions on a large-scale capital intensive energy production unit, we must carefully consider all the multiple factors affecting the business environment, which can have an effect on profitability in the future.

In January 2008, the EU released the so-called climate and energy package, which contains the propositions to increase the use of renewable energy, reduce greenhouse gases and renew emissions trading directives. The EU has committed to reduce 20% the greenhouse gases by 2020 to the level of 1990 (COM, 2007).

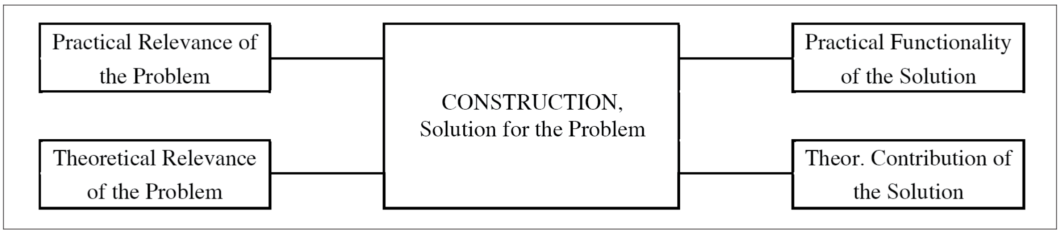
Continuous changes in the operating environment have forced the actors in the energy industry to create new operating modes to survive and prepare for the changes that will take place in the future. Because of the continuous changes, it is difficult to predict the future and also hard to evaluate the profitability of investments made for several decades. Investment decision making can be very complex. Many different factors have an influence to the investment decision. It is important to know the best practices. This means that accounting practices and information systems have to be handled as a unit. Developing systems which use information systems and accounting practices in the right way is a complex problem, including the accounting practice problem.

In the research, we developed an instrument that utilises the features of Analytic Hierarchy Process (AHP). This instrument will support the decision-making process in analysing the factors affecting energy investments. The model has been tested with the case companies. The case companies are operating in the energy field in Finland, in the Nordic energy market area. Their objectives have been similar when making investment decisions: they try to invest in energy production units that are profitable and also own these investments through the whole life cycle in order to maximise the profits in the long term.

The focus of the research is Finland, because while defining a dynamic decision-making model for energy industries, one has to carefully consider the national opportunities and restrictions in the operating environment. Energy production is implemented in accordance with the national and international regulations and instructions. When making decisions on energy investments, the local context has to be taken into consideration both in production and in selling the product.

In this research, an innovative and theoretically justified solution is created for a practical problem. The results are tested with a weak market test. The approach is constructive, as can be seen in Figure 3.

Figure 3 The constructive research approach



Source: Kasanen *et al.* (1993)

The research method is action research, in which the research is combined with the existing theoretical knowledge and after that, the empirical results are compared to the theory. The external validity of the dynamic decision-making model developed in the research has been tested with a ‘weak’ market test, including a questionnaire for the specialists in the industry. The internal validity of the model was tested with a new, alternative questionnaire to a part of the specialists and compared with the inconsistency ratio. The implementation (IMPL) index measures the importance of improving and pressure to improve.

The action research method is traditionally qualitative. In this research, there are parts of both the qualitative and quantitative research methods. In the qualitative part, the dynamic decision-making model is formed with the AHP. In the quantitative part, a weak market test is made for the former model.

There is a changing process going on in the energy industry. Due to this process, investments in production have been significantly reduced during the last decade. Uncertainty has grown with the capital-intensive, long-term energy production modes. The circumstances described above support the need for this research among the decision makers. In Varho’s (2007) doctoral thesis, which concentrates on wind power, one main idea is that the parties operating in the energy industry have significantly different ideas about using wind power as the energy production mode in the future. This favours the need for this kind of research.

2 Methods

Saaty's (1980) AHP is the main method used in this paper. Saaty's AHP is a model of the way in which the human mind conceptualises and structures a problem. The method has been used in various decision settings dating as early as the 1970s in the design of alternative future outcomes for a developing country (Saaty, 1977), the evaluation of political candidates (Saaty and Bennett, 1977) and the allocation of energy resources (Saaty and Mariano, 1979).

AHP is a powerful and flexible decision-making process to help in prioritising and make a decision when both the qualitative and quantitative aspects of a decision need to be considered. By reducing complex decisions to a series of pairwise comparisons, then synthesising the results, AHP not only helps decision makers arrive at the best decision, but also provides a clear justification of what the important decision is. AHP is a multi-attribute decision instrument. AHP's goal is to integrate different measures into a single overall score for ranking decision alternatives with pairwise comparisons of the chosen attributes.

The AHP model is a decision-making framework that assumes a one-way hierarchical relationship among different decision-making levels. The AHP model has three basic steps (Saaty, 1980; 1999):

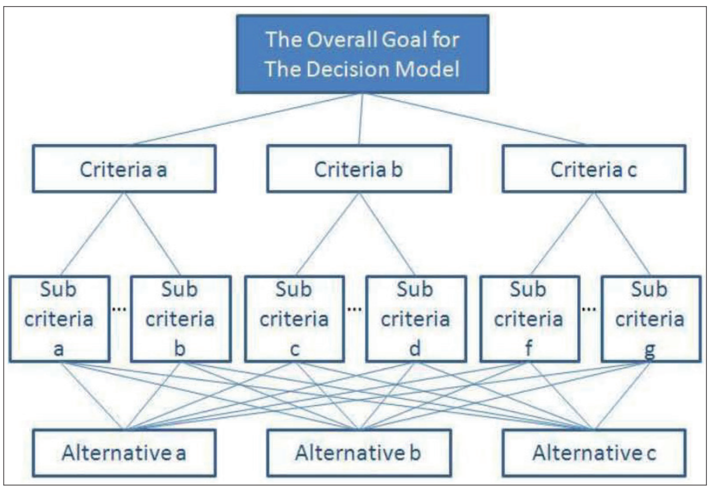
Step 1 The development of a decision hierarchy. The top element of the hierarchy is the overall goal for the decision model. The hierarchy is a type of a system where one group of factors influences another set of factors.

Step 2 Pairwise comparisons are conducted to estimate the relative importance weights (or allocations) of the various elements on each level of the hierarchy.

Step 3 The obtained weights are integrated to develop an overall ranking of the decision alternatives.

The hierarchy consists of the overall objective, criteria, subcriteria and decision, alternatives, described in Figure 4.

Figure 4 The hierarchy structure of the AHP model finds the overall goal for the decision problem (see online version for colours)



Source: Rangone (1996)

By using AHP as a decision-making tool, the following axioms need to be fulfilled (Rangone, 1996):

- if the alternative of criterion A is n times preferred to B, then B is 1/n times as preferred as A (reciprocal axiom)
- the elements are comparable if only the pairwise comparison is meaningful (homogeneity axiom)
- comparison at the lower level depends on the element at the higher level (dependency axiom)
- a new evaluation is required for the new hierarchy, if any criterion in the hierarchy shall change (expectations axiom).

The structure of the AHP method helps recognise the factors affecting decision making more accurately and, in addition, helps acknowledge the mutual correlation between each factor. AHP makes it possible to combine accurate, measurable knowledge (costs, interest rates, measures) with intuition and personal valuations within the same decision-making model.

In this research, the AHP model was created to match the special characteristic of the Finnish energy industry. The creation of the hierarchy was conducted by the observations of the researcher, which have been completed with the views of the industry's specialists.

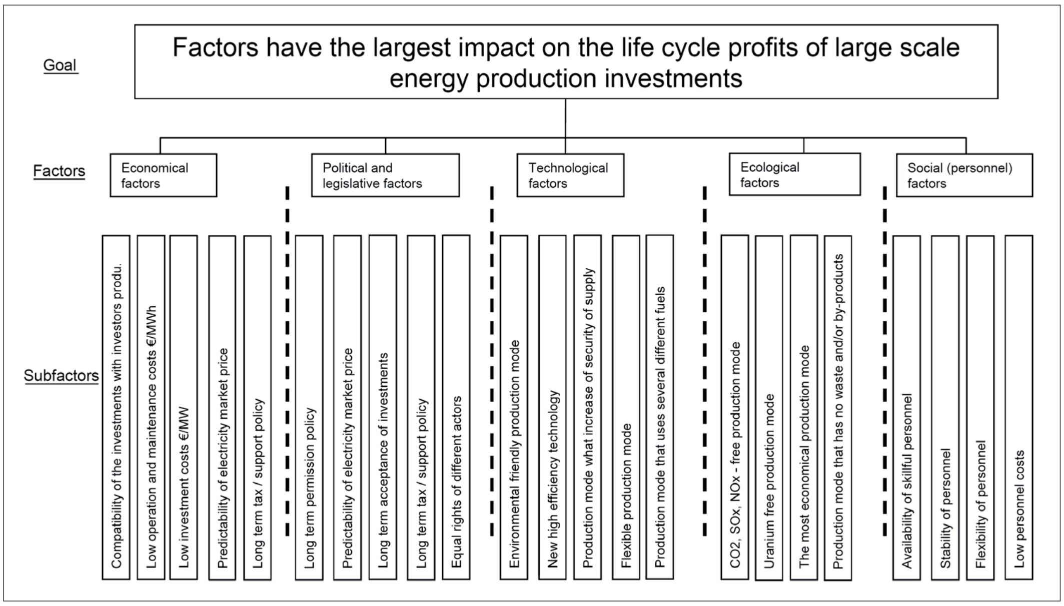
3 Developing the hierarchy

The approach and structure of this study was determined by several meetings and discussions with experts from case companies which were linked to this research area. Most of the experts are companies' managing directors, who were also selected to answer the AHP questionnaire.

The hierarchy of this research is meant to observe both the qualitative and quantitative factors affecting the investments made in energy production. The hierarchy consists of three different levels: the hierarchy of the problem, factor and subfactor. The goal of the research is to find out what factors have the largest impact on the life cycle profits of large-scale energy production investments. At the second level of the hierarchy, there are five criteria levels. It consists of the economical, political and legislative, technological, economical (environmental) and social factors. At the third level of the hierarchy, there are more detailed factors which define the upper level. See Figure 5, which shows the hierarchy of the problem.

In creating the hierarchy, the mode of action existing in the industry has been transported into the model based on the observations of the researcher. The grouping of the hierarchy is formed by creating the contact networks of the companies acting in the industry. In forming the network, different factors have been analysed and this led to five different criteria. In every criteria, there is a group of subfactors that affects the criteria. All of the subfactors form a group that has an effect on the life cycle profits of large-scale energy production investments. The following paragraphs describe the factors of the hierarchy model in more detail.

Figure 5 The hierarchy of the problem



3.1 Factors have the largest impact on the life cycle profits of large-scale energy production investments

Multiple different factors have an effect on the life cycle profits of large-scale energy production investments. Economical, political and legislative, technological, ecological as well as social factors have to be taken into consideration in decision making.

3.2 Economical factors

The economical factors are the direct monetary effects on the life cycle profits of energy production investments. These are the compatibility of the investments with investors' production portfolio, low investment costs (€/MW), low operation and maintenance costs (€/MWh), long-term tax/support policy and the predictability of the electricity market price.

3.3 Political and legislative factors

The political and legislative factors have an effect on the investment process with direct or indirect regulation. These are the long-term permission policy, the predictability of the electricity market price, the long-term acceptance of investments, the long-term tax/support policy and equal rights of the different actors.

3.4 Technological factors

The technological factors describe the techno-economic features of the investment mode. These factors set restrictions on the usability and economy of the energy production mode. These are the environment-friendly production mode, new high-efficiency technology, production mode that increases the security of energy supply, flexible production mode and the production mode that uses several different fuels.

3.5 Ecological (environmental) factors

These factors describe the level of environmental friendliness of the investments' energy production mode. It has to fulfil the existing demands and become related to the environmental demands. These are the CO2, Sox and NOx-free production mode, the uranium-free production mode, the most economical production mode and the production mode that has no waste and/or byproducts.

3.6 Social (personnel) factors

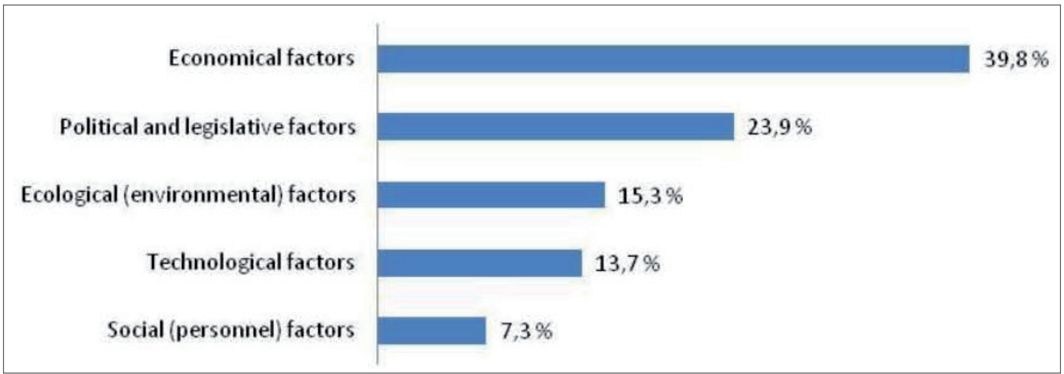
The social (personnel) factors define the share of personnel costs of the life cycle profits of the investment. These are the availability of skilful personnel, the stability of personnel, the flexibility of personnel and low personnel costs.

The results of the research were collected with a questionnaire, in which the specialists compared the importance of their different potential competitive priorities and subpriorities to the others' priorities and subpriorities. They answered with a 17-point scale in which the midpoint meant that those compared factors are equally important.

4 Results and analysis

The results of AHP were similar despite the fact that the interviewees represented various specialists in the industry. The relative importance of each of the examined main factors showed a consensus on which were the most important factors. The most important ones were the economical factors (39.8%) and the second most important ones were the political and legislative factors (23.9%). Other factors, *i.e.*, the ecological factors (15.3%), technological factors (13.7%) and social factors (7.3%), were less significant when considering the goal of the research. The results show that the political and legislative factors strongly direct decision making in the energy industry. Figure 6 shows all the relative weights of the factors.

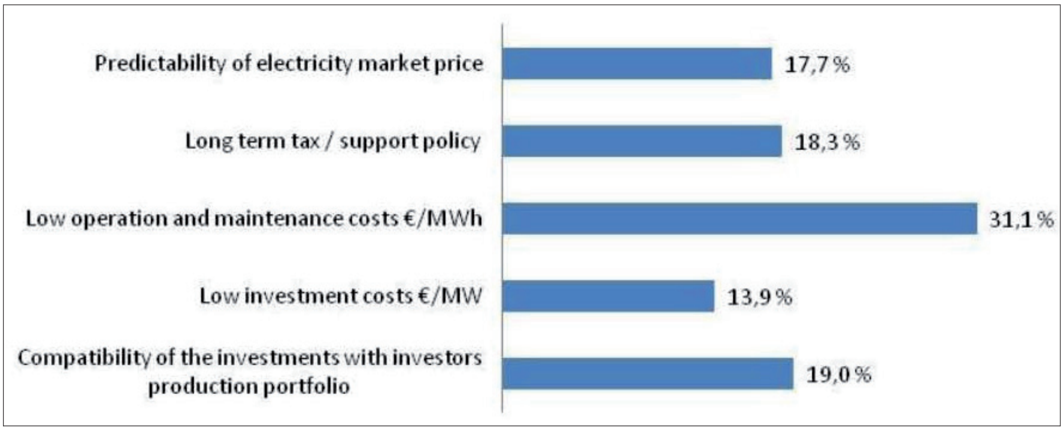
Figure 6 The weights of the factors that have the largest impact on the life cycle profits of large-scale energy production investments (see online version for colours)



When analysing the results, it can clearly be seen that when making profitability calculations for large-scale energy production investments, political wild cards and their importance have to be taken into serious consideration. The importance of social factors (personnel) is rather low, because it is typical for the industry to try to automate as many functions as possible by taking safety factors into account in order to minimise the employees needed for the investment in question.

Figure 7 shows that the economical factors are the most influential ones in decision making. This leads to the fact that its subfactor 'low operational and maintenance costs' (31.1%) overpowers a single factor. This factor supports the production modes that have low fuel costs, such as water and wind power, which are emission-free and are also less vulnerable for political risks. The results show that the interest in building energy production facilities that use fossil fuels has descended. The specialists classify all of the other subfactors as equally important.

Figure 7 The economical subfactors (see online version for colours)



The long-term tax/supporting policy (28.4%), the predictability of electricity market prices (24.1%) and the long-term acceptance of investment (22.8%) emerged as the most influential ones among the political and legislative subfactors. Figure 8 shows all the relative weights of the political and legislation subfactors.

Figure 8 The political and legislative subfactors (see online version for colours)

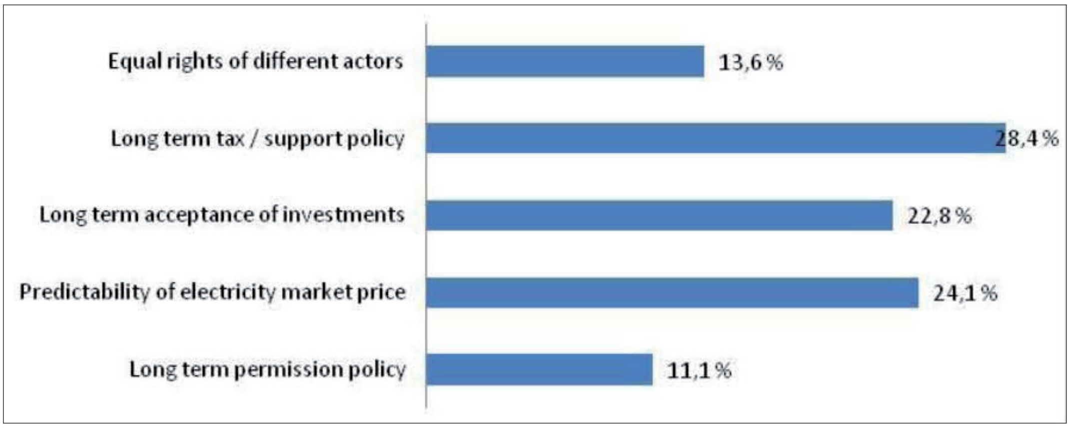
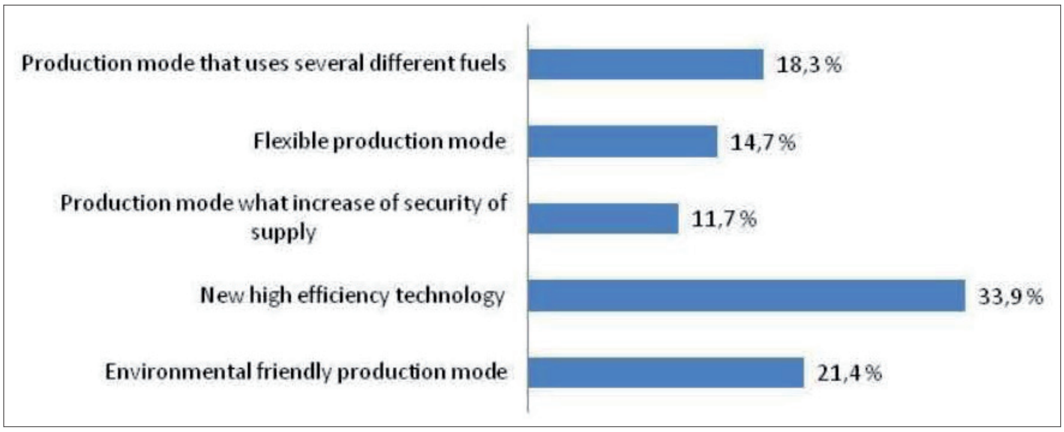


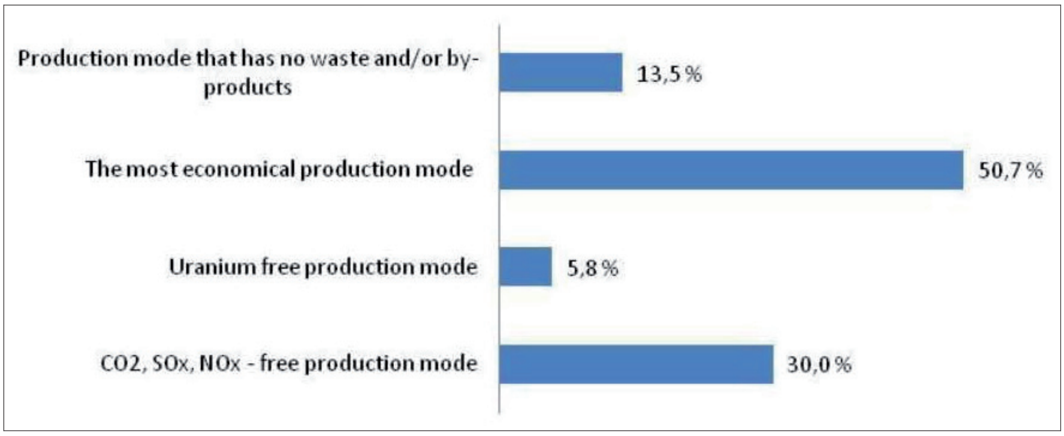
Figure 9 shows that the most influential factors among the technological subfactors are high-efficiency technology (33.9%), the environment-friendly production mode (21.4%) and the production mode which utilises several fuels (18.3%).

Figure 9 The technological subfactors (see online version for colours)



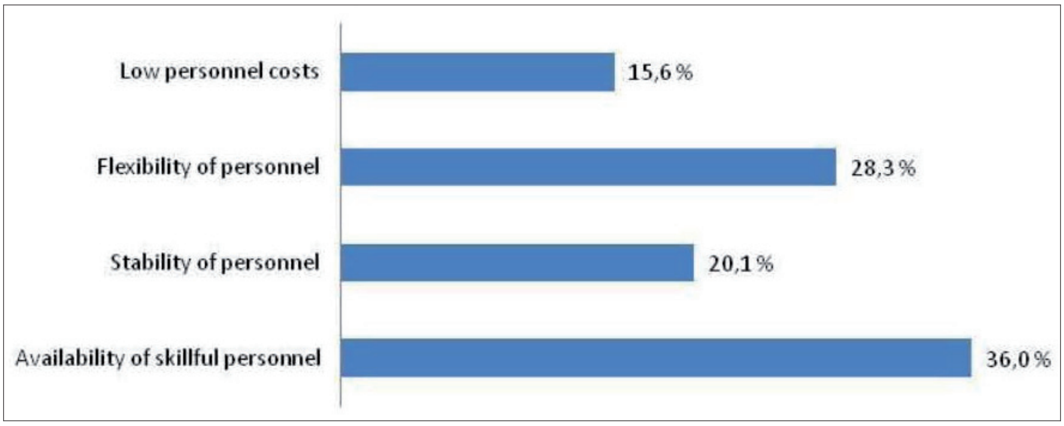
Among the ecological (environmental) factors, the most influential subfactors were the most economical production mode (50.7%) and the CO_2, SO_x and NO_x-free production mode (30.0%). It is worth mentioning that according to the case companies, it does not matter which ways environmental acceptance is being achieved. In practice, the companies prefer the most economical option. This result strengthens the concept that fossil fuel-free production modes are transcendent in the markets. Resulting from the question arrangement, the case companies do not consider that using uranium as a source of energy is a problem. Figure 10 shows all the relative weights of the ecological subfactors.

Figure 10 The ecological (environment) subfactors (see online version for colours)



The availability of skilful personnel (36.0%) and their flexibility (28.3%) are the most important ones when viewing the social (personnel) factors. In the Finnish energy industry, the significance of personnel flexibility has become a remarkable factor alongside the availability of skilful employees (see Figure 11).

Figure 11 The social (personnel) subfactors (see online version for colours)



5 Evaluation of results and further research

The results of the AHP analysis method explained that the interrelationships of factors have the largest impact on the life cycle profits of large-scale energy production investments. The reliability of the research has been increased by making a duplicate questionnaire for the specialists who answered the AHP questionnaire. The specialists' opinions did not change when they answered the main questionnaire and the duplicate questionnaire. If all the specialists were personally interviewed, the results would have been more reliable. If more specialists were interviewed in the case companies and the interviews were done several times, an even higher validity of the results would have been achieved so that the results could be compared better to each other. The accuracy and reliability of the results can be raised if some other scientific method would be used alongside AHP.

The inconsistency was calculated to assure the reliability of the pairwise comparison results. The values under 0.2 are considered reasonably inconsistent, as Hafeez *et al.* (2000) and Takala *et al.* (2003) suggested. The inconsistency ratio of the answers was under 0.2 in every factor, calculated by using the geometric mean value (see Figure 12).

In order to gain opportunities to analyse and enable better pairwise comparison, Takala's (2000) IMPL index was used in this study. According to Takala (2000), IMPL increases the sensitivity of the deviation in the factors and improves the possibility to compare difficult cases to each other. The IMPL value is calculated by dividing the standard deviation of an attribute assessment result by the value of a corresponding average value. All the IMPL values of this research are under one (<1), which means that the result of the research was reliable (see *e.g.*, Takala *et al.*, 2003). Figure 13 presents the IMPL index of the factors that have the largest impact on the life cycle profits of large-scale energy production investments.

The inconsistency ratio of individual answers was more than 0.2, which shows that the specialists who answered the questionnaire categorised some of the factors inconsistently. This partly explains why large-scale energy production investments have not been made in the Finnish energy industry. The values of the IMPL indexes in the political and legislative, technological and social (personnel) factors also support this fact.

Figure 12 The inconsistency ratio of the research result calculated by using the geometric mean value (see online version for colours)

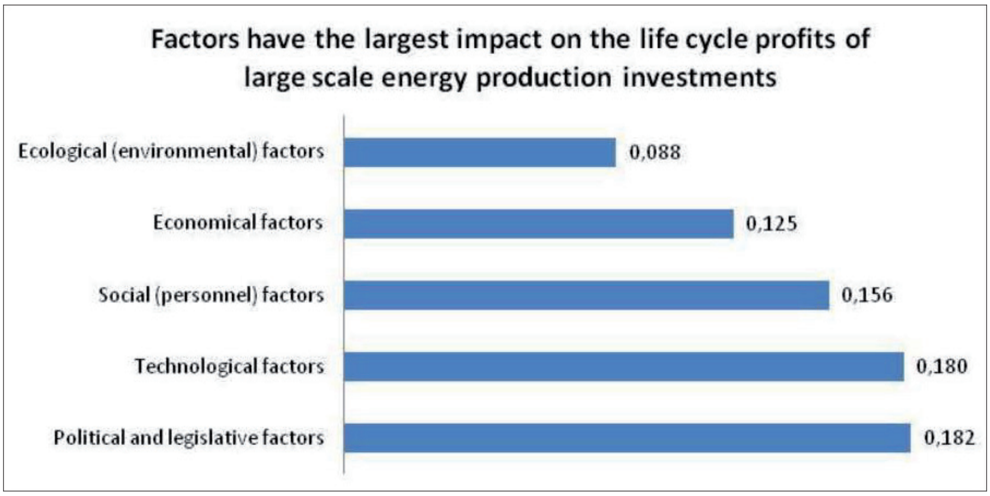
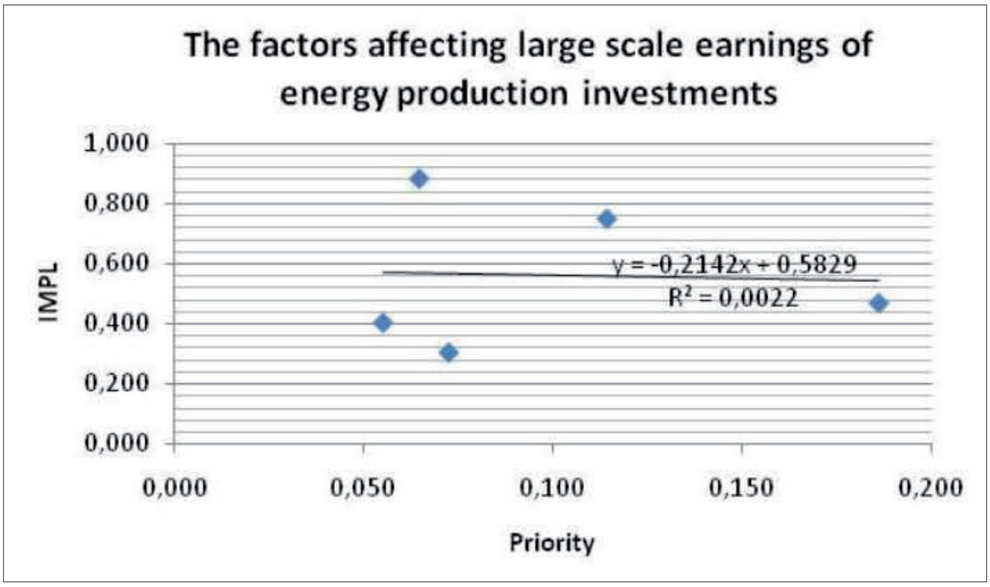


Figure 13 The IMPL index of the factors that has the largest impact on the life cycle profits of large-scale energy production investments (see online version for colours)



There are several topics for further study in the subject matter. The results of this research show the factors that the specialists consider the most influential ones when planning investments. The research should be deepened by finding out what energy production modes contain most of these shown factors and how it is possible to minimise the uncertainties so that large-scale investments could be executed in a cost-effective way.

The applicability of the results should be further improved with a more detailed examination of single subfactors or the selected production modes so that a more detailed model of selected subfactors could be done outside the focus of this research. The hierarchy model constituted in this research could also be modified so that the factors could conversely be tested from the power plant suppliers' or the political decision makers' point of view.

6 Conclusion

The results showed that the main factors which have an effect on the energy sector investments' life cycle profits are both the financial and political and legislative factors. When analysed in more detail, the most significant subfactor among the economical factors was low operational and maintenance costs (€/MWh). Among the political and legislative subfactors, the most significant subfactor was the long-term tax/supporting policy. The results confirm the preconceptions of an industry which is going through constant change and where practical challenges emerge from that change.

The companies have to use complicated analytical methods for investments. The model results based on the AHP also give mainly quantitative information on the weight value of the factors. The goals set for the research were achieved: the factors and subfactors affecting large-scale energy production investments in the Finnish energy industry were identified and analysed by using the AHP method. The results clearly showed that with the model, the important factors in the investment decision-making process are found.

The research is a contribution for science because it fulfils the goal that was set for this research and whose starting point lies on the previous literature on the matter. A new model to a practical problem is created with a theory which is tested with the specialists in the energy industry. At the same time, the industry's concepts are widened. In the future, it is obvious that certain changes are taking place in the industry and, therefore, the dynamic multicriteria decision-making process will help make decisions.

References

COM (2006) *Green Paper, A European Strategy for Sustainable, Competitive and Secure Energy*, Commission of the European Communities.

COM (2007) *An Energy Policy for Europe*, Commission of the European Communities.

Hafeez, K., Zhang, Y., Abdelmeguid, H., Malak, N. and Iqbal, S. (2000) 'Firm competence evaluation framework using AHP', *1st International Conference of System Thinking in Management*, pp.225–230.

Jylhä, R. (2006) 'Sähkönhuollosta sähkömarkkinoihin', Doctoral dissertation, Department of Business Law, University of Vaasa.

Kasanen, E., Lukka, K. and Siitonen, A. (1993) 'The constructive approach in management accounting research', *Journal of Management Accounting Research*, Vol. 5, pp.241–264.

Rangone, A. (1996) 'An analytical hierarchy process framework for comparing the overall performance of manufacturing department', *International Journal of Operations & Production Management*, Vol. 16, No. 8, pp.104–119.

RWE (2007) *Facts & Figures*, October, RWE AG.

Rydén, B. and Fritz, P. (2006) 'Costly early learnings from the first year of the EU ETS: unforeseen price levels hit industries hard', in B. Rydén (Ed.) *In Ten Perspectives on Nordic Energy*, Stockholm: Elforsk, pp.51–62.

Saaty, T. (1977) 'A scaling method for priorities in hierarchical structures', *Journal of Mathematical Psychology*, Vol. 15, pp.234–281.

Saaty, T. (1980) *The Analytic Hierarchy Process: Planning, Priority, Resource Allocation*, New York: McGraw-Hill.

Saaty, T. (1999) *Decision Making for Leaders*, 3rd ed., Pittsburgh, PA: RWS Publications.

Saaty, T. and Bennett, J. (1977) 'A theory of analytical hierarchies applied to political candidacy', *Behavioral Science*, Vol. 22, pp.237–245.

Saaty, T. and Mariano, R. (1979) 'Rationing energy to industries: priorities and input-output dependence', *Energy System Policy*, Vol. 3, No. 1, pp.85–111.

Takala, J. (2000) 'Analyzing and synthesizing multifocused manufacturing strategies by analytic hierarchy process', *ICPQR 2000 The 9th International Conference on Productivity & Quality Research*, Israel, pp.25–28.

Takala, J., Huhtala, O-T. and Zgodavova, K. (2003) 'Developing a model for competitive outsourced payroll administration by comparative benchmarking experiences from other industries', *International Journal of Quality Innovation Prosperity*, Slovak Republik.

The Big Leap (2006) *Utilities Global Survey 2006*, PricewaterhouseCoopers.

Varho, V. (2007) 'Calm or storm? – Wind power actors' perceptions of Finnish wind power and its future', Doctoral dissertation, Department of Biological and Environmental Sciences, University of Helsinki.

388 *Int. J. Sustainable Economy, Vol. 1, No. 4, 2009*

Competitive priorities of investment strategy: case wind power

Tomi Mäkipelto

Department of Production,
Faculty of Technology,
University of Vaasa,
BO.Box 700,
Vaasa FI-65101, Finland
E-mail: tomi.makipelto@student.uwasa.fi

Abstract: The goal of the research was to evaluate the major factors affecting the decision-making process of investments made in wind power, especially in Finland, from the investors' and suppliers' point of views. The theoretical part of the current research consists of the competitive priorities of investment strategy and analytic hierarchy process model theories. This work links to the existing scientific research. The results showed that some investors' and suppliers' expectations for the competitive priorities of investment strategies' main factors differ from each other. The process will also help the suppliers to understand the investors' expectations.

Keywords: agility and leanness model; AHP; analytic hierarchy process; multi-criteria decision making; RAL model; responsiveness; sustainable economy; wind power.

Reference to this paper should be made as follows: Mäkipelto, T. (2009) 'Competitive priorities of investment strategy: case wind power', *Int. J. Sustainable Economy*, Vol. 1, No. 4, pp.388–402.

Biographical note: Tomi Mäkipelto MSc (Tech.), Post graduate student in Faculty of Technology at the University of Vaasa in Finland. Master of Science in Technology at the Tampere University of Technology 2005. His field of interest is the investment decision process in the energy industry, sustainable economy and renewable energy resources. His work experience background: Managing Director in Rajakiiri Oy, EPV Tuulivoima Oy and Suomen Merituuli Oy (investment companies, focus investment to windfarms in Finland) 2007, Vice President, Corporate Strategy and Development in Etelä-Pohjanmaan Voima Oy 2008, Development Manager in Etelä-Pohjanmaan Voima Oy 2006–2008, Expert, Business Economics in Etelä-Pohjanmaan Voima Oy 2006–2005.

1 Introduction

The energy industry has become one of the most spoken topics in global economy. Nowadays, it is almost impossible to find a political discussion which would not be affected by such topics as the availability or production of sustainable energy. Energy resources and ownership of these resources even cause wars between nations.

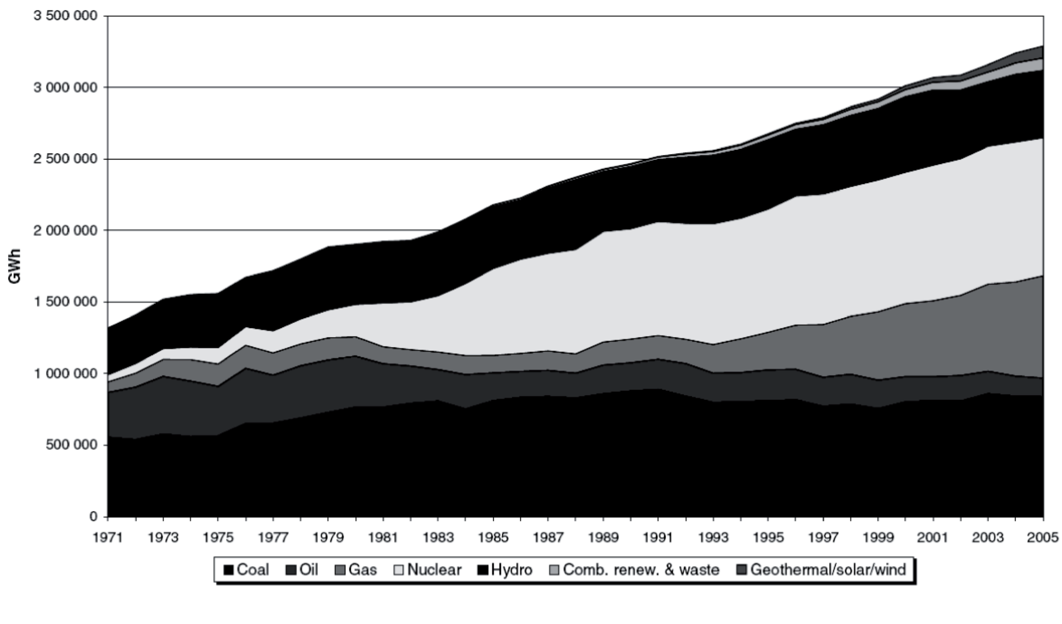
Together with the soaring global economy the need for electricity escalates. The consumption of electric energy in industrial countries has been at a high level for decades and nothing seems to restrain it in the next few years. Especially technological development has increased the demand for electricity. Figure 1 presents how the evolution of electricity generation shown by fuels has evolved from 1971 to 2005 in Europe.

The environmental burden of energy production is both local and global. From the ecological point of view, the subtext of the industry is global although the companies act locally producing energy for the consumers nearby. This causes a contradictory situation between nations because of the differences in objectives. In some parts of the world, the main objective is to raise living standards and to create industrial culture no matter what the costs are, while in more developed countries the main objective is to fine-tune the national energy production portfolios to be more environmental friendly. This problem has generated instability for the global decision making in energy politics: on one hand, energy production should be raised cost efficiently and, on the other hand, the environmental aspects should also be taken into consideration.

In Europe, the discussion of energy policy has recently concentrated on renewable sources of energy production. The official goal of European Union is to decrease the greenhouse gas by 30% in the industrial countries by 2020 compared to the level of 1990. By the year 2050, the emissions should be cut down by 50% compared to 1990 (COM, 2007).

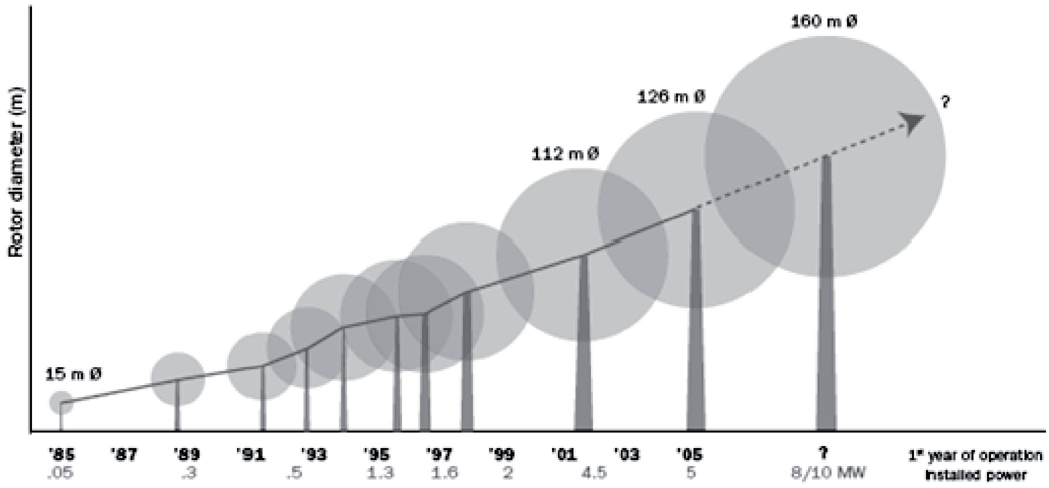
Papler and Bojnec (2007) have been researched the impacts of market deregulation on enterprise organisational and business behaviours, and on consumers' satisfaction with quality of services especially in Slovenia. The energy industry in Finland, and also in many other countries, is exceptional because of not only the limitations set by ownership and cost structure, but also limitations set by the official supervision and special technical features.

Figure 1 Evolution of electricity generation shown by fuels from 1971 to 2005 in Europe



Source: International Energy Agency (2007).

Figure 2 The size of wind turbines at market introduction



Source: The Advisory Council of the European Wind Energy Technology Platform (2006).

1.1 The present state and future prospects of wind power

Wind power energy has been produced for centuries. In practise, the technology used in wind power production has reached industrial scale only in the 21st century. In the past 20 years, the efficiency of wind farms has increased a hundred-fold from 50 to 5 MW. At the same time, the production costs have reduced about 50%. The hub high of wind power units has risen from 50 to 100 m or more in the last decade. Figure 2 presents how the square areas covered by the blades in wind power units have been growing year after year.

At the moment, there are 57 GW capacities for wind power which is 18% more than a year before (The European Wind Energy Association, 2008).

Figure 3 shows that the capacity of wind power has strongly concentrated in Germany and Spain. This is a result of a very strong support system for wind power building over the years.

1.2 The state of wind power market in Finland

In the Nordic countries, wind power holds one of the highest possibilities for investors in the energy field, because it has not been used much. The advantage of wind power is that the building from planning stage to production stage takes about four years, whereas other energy production forms, such as nuclear power, take about ten years. In favour of wind power is also the fact that wind power investments can be made in stages of few wind power units (megawatts) optimising the building costs, whereas building other energy production possibilities you have to built tens, hundreds or even thousands of megawatts at once.

Figure 3 Cumulative wind power installed in Europe by the end of 2007

Source: The European Wind Energy Association (2008).

In selecting the areas for wind power production, one has to balance between productivity and environmental values. On one hand, fell areas would be very productive but, on the other hand, the wind power farms built on top of fells can be seen from kilometers away and are rather dominant in the environment. Wind power farms built on the coastal area hardly change the existing environment at all and have moderate wind. This makes them primary choices when building optimal wind power in Finland.

Long-term profitability of investments made in wind power industry depends on the windiness of the area, the usability of wind power farms, investment and maintenance costs, and also on the market price of electricity and the level of possible support systems.

The markets of wind power industry in Finland are quite challenging, as seen from the equipment supplier's point of view. Building of wind power farms has been undergoing a very strong growth internationally and the Finnish wind power technology markets have been concentrating mainly on exporting.

For the present, there is very little experience on the utilisation, operation and maintenance costs in very cold conditions like in Finland. By the end of 2007, only 110 MW wind power megawatts have been built in Finland (The European Wind Energy Association, 2008). The wind power industry in Finland is undergoing a radical change. The energy producers predict that there is a possibility for new launches in the support systems provided by the government. That is the reason why many enterprises have been starting to make reservations for new wind power areas.

1.3 The purpose of the research

The purpose of this research is to evaluate competitive priorities of investment strategy from the wind power investors' point of view and to compare the findings with the opinions of wind power equipment suppliers. The objective is to find the key factors that have an affect on wind power investments from both the wind power investors' and equipment suppliers' perspective. The suppliers can utilise these findings when constructing their strategies.

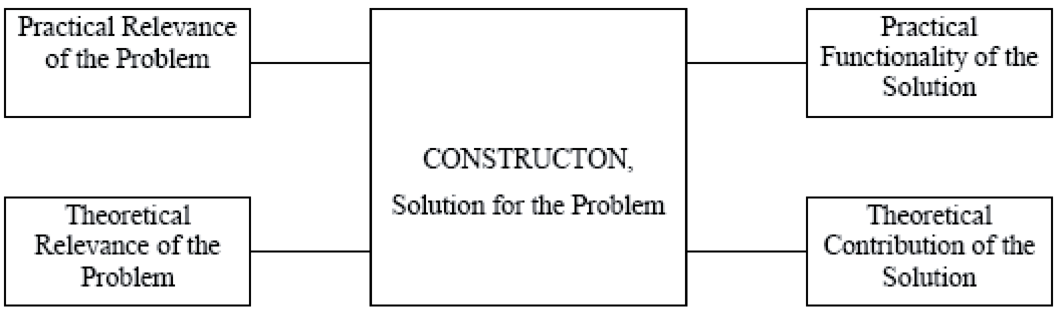
The researchers are using methods in the multi-focused manufacturing strategies. Takala (2002) was analysing, synthesising and implementing multi-focused competitive strategies empirically. The empirical part of this research was made by using the responsiveness, agility and leanness (RAL) model quantification as the multi-focused manufacturing strategy methodologies. In this research, empirical data was collected by using the researcher's observations including informal discussions and by using formal questionnaires.

The focus of this research is geographically limited to Finland. This is because when implementing a research in the field of energy industry, it is crucial to take into account national possibilities and restrictions concerning the business environment in question. Energy production is guided by national and international restrictions, but always produced locally because of the restricted transferability. This whole complex with manufacturing and selling the final product has to be adjusted to the local context when making decisions about energy investments.

In this research, an innovative and theoretically justified solution has been created to answer a practical problem. The results have been tested with a weak market test. The approach is constructive, as can be seen in Figure 4.

The research method is an action research, in which the research is combined with the existing theoretical knowledge and after that the empirical results are compared to the theory. The external validity of the dynamic decision-making model developed in the research has been tested with a 'weak' market test including a questionnaire for the specialists in the industry. The internal validity of the model was tested with a new, alternative questionnaire to a part of the specialists and it was also compared by the inconsistency ratio. The implementation index (IMPL) measures importance and pressure to improve.

Figure 4 Constructive research approach



Source: Kasanen, Lukka and Siitonen (1993).

The action research is traditionally qualitative. In this research, there are parts of both the qualitative and quantitative research methods. In the qualitative part, the dynamic decision-making model is formed with the analytical hierarchy process (AHP). In the quantitative part, a weak market test is made for the former model.

The energy industry is undergoing a changing process. Due to this process, investments in production have significantly reduced during the last decade. Uncertainty has grown with the capital intensive, long-term energy production modes. Circumstances described above support the need for this research among the decision makers. In Varho's (2007) doctoral thesis, which concentrates on wind power, one main idea is that the parties operating in the energy industry have significantly different ideas about using wind power as the energy production mode in the future. This fact also favours the need for this kind of research.

2 Methods

Saaty's (1980) AHP was the main method used in this article. Saaty's AHP is a model of the way in which the human mind conceptualises and structures a problem. The method has been used in various decision settings, dating as early as the 1970s, in the design of alternative future outcomes for developing countries (Saaty, 1977), the evaluation of political candidates (Saaty and Bennett, 1977), the allocation of energy resources (Saaty and Mariano, 1979) and the logistics of industrial location (Alberto, 2000).

AHP is a powerful and flexible decision-making process that helps in prioritising and in decision making where both the qualitative and quantitative aspects of a decision need to be considered. By reducing complex decisions to a series of pair-wise comparisons and then synthesising the results, AHP not only helps decision makers arrive at the best decision, but also provides a clear justification of what is the important one. AHP is a multi-attribute decision instrument. AHP's goal is to integrate different measures into single overall score for ranking decision alternatives with pair-wise comparisons of the chosen attributes.

The AHP model is a decision-making framework that assumes one-way hierarchical relationship among different decision-making levels. The AHP model has three basic steps (Saaty, 1980, 1999):

1 Development of a decision hierarchy. The top element of the hierarchy is the overall goal for the decision model. The hierarchy is a type of system where one group of factors influences another set of factors.

2 Pair-wise comparisons are conducted to estimate the relative importance weights (or allocations) of the various elements on each level of the hierarchy.

3 The weights obtained are integrated to develop an overall ranking of decision alternatives.

The structure of the AHP method helps to recognise the factors affecting decision making more accurately and, in addition, it helps to acknowledge the mutual correlation between each factor. AHP makes it possible to combine accurate, measurable knowledge (costs, interest rates, measures) with intuition and personal valuations within the same decision-making model.

The AHP model is based on three principles:

1 decomposition of the decision problem

2 comparative judgment of the elements

3 synthesis of the priorities.

In this research, the AHP model was created by using the RAL concept and the special characteristics of the Finnish energy industry. Creating the hierarchy was conducted by the observations of the researcher, which have been completed with the views of the industry's specialists.

The RAL concept has created an understanding of the success factors of logistics, but it is relevant for all the strategic operations and management of operations, and for manufacturing and investment strategies as well (Takala, 2002). Figure 5 shows the main keystones of the RAL concepts.

The main dimensions of RAL are:

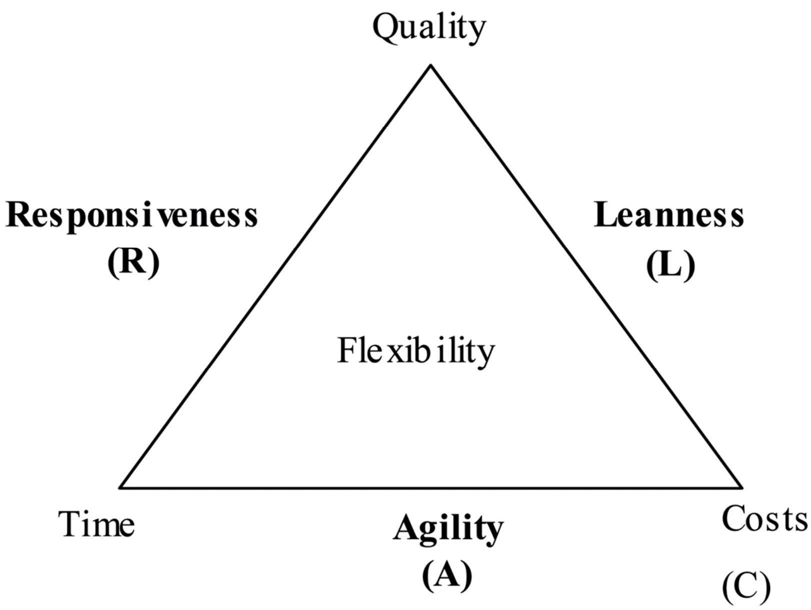
1 Responsiveness which means the speed by which the system satisfies unanticipated requirements.

2 Agility which means the speed by which the system adapts to the optimal cost structure.

3 Leanness which means minimising waste in all resources and activities.

In the middle of the triangle is flexibility which is the focused core concept. It signifies the product mix, volatility in conditions (changes in volumes), complexity (technology level, the number of modules and modularity) and life cycle flexibilities (Takala, 2002; Takala and Toshev, 2007).

Figure 5 Responsiveness, agility and leanness concepts



Source: Takala (2002).

3 Modified responsiveness, agility and leanness-model

The RAL model has been modified to explore the investment decisions made in the wind power industry. The hierarchy is based on the discussions engaged with the experts in the industry. Figure 6 shows the modified hierarchy for this research.

The modified RAL model gives the most relevant and comparable results for the research. Both energy fields investors' and equipment suppliers' points of views have been taken into account when forming the hierarchy.

When forming a modified hierarchy, Mikko Kosonen's and Yves Doz's book Fast strategy has been utilised (Doz and Kosonen, 2008). According to them, the companies should form their strategies to be more flexible and the strategic decisions should be agile. It should be possible to reform the companies' strategies continuously: weekly, daily or even hourly. Figure 7 shows the main components of strategic agility.

The meaning of strategic sensitivity is both the sharpness of perception and the intensity of awareness and attention. Resource fluidity means the internal capability to reconfigure business systems and redeploy resources rapidly. Collective commitment means the ability of the top team to make bold decisions fast.

With the RAL model, the research findings give information which helps to control the strategic sensitivity of the company. The six main criteria which were chosen in the end to be compared to the hierarchy model were the total costs of investment, customer focus, the quality of the product, total delivery, flexibility and supplier's know-how.

Figure 6 Modified responsiveness, agility and leanness model

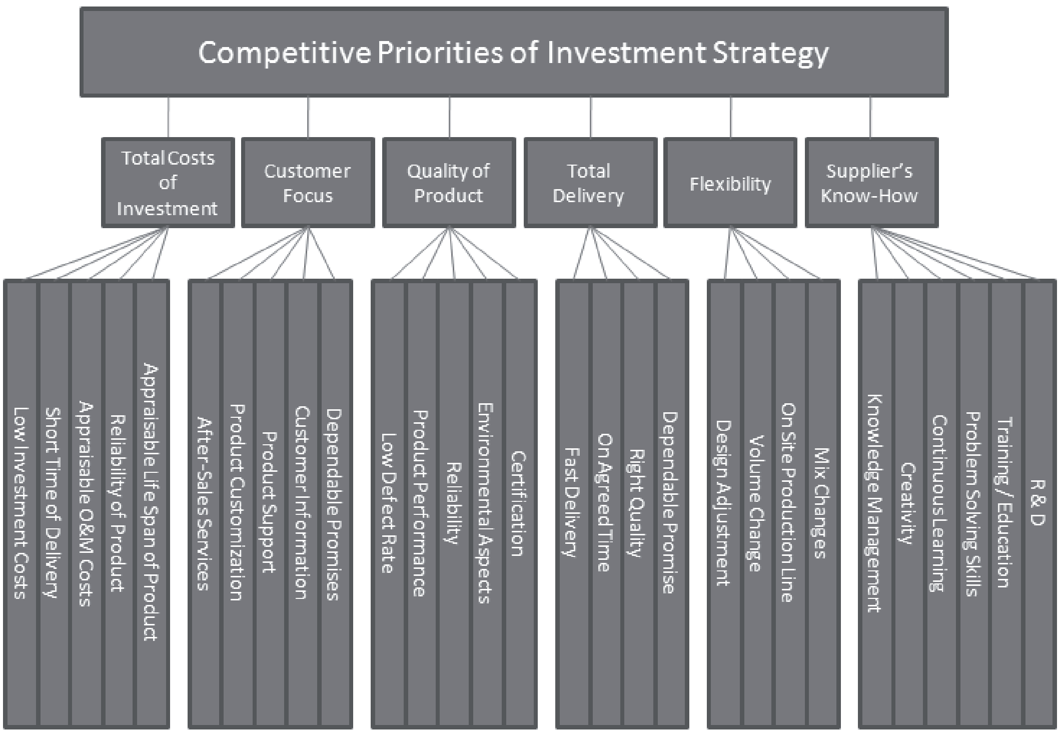
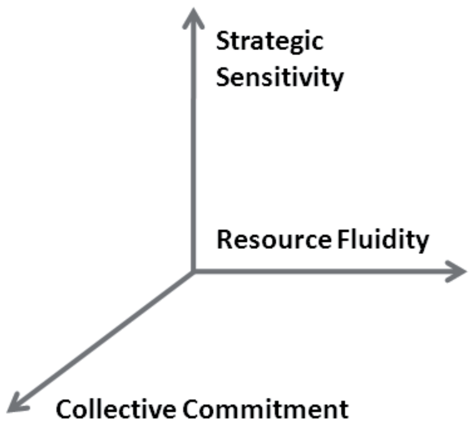


Figure 7 Key parts of strategic agility



Source: Doz and Kosonen (2008).

4 Results and analysis

The results of AHP were similar despite the fact that the interviewees represented various specialists in the industry, i.e. both investors and suppliers. Relative importance of each of the examined main factor showed consensus with the most important factors.

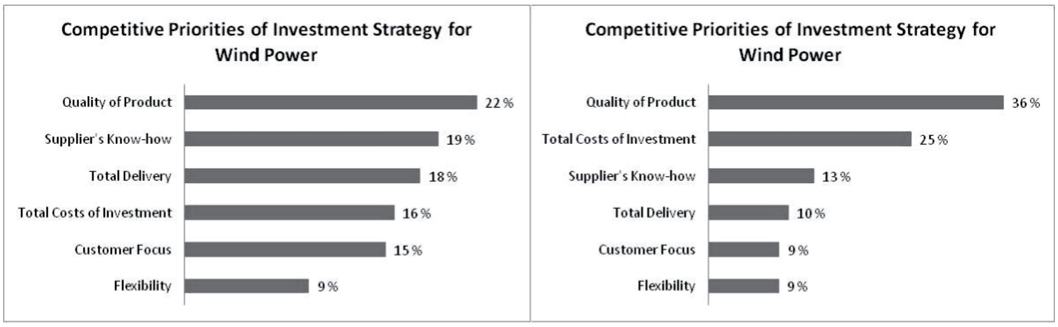
The most important factor was the quality of product. The least important ones were customer focus and flexibility both from the investors' and suppliers' viewpoints. The results show that from the investors' point of view the total costs of investment is the second important factor. However, from the suppliers' point of view this is not significant because they see that supplier's know-how and total delivery are more important factors. Figure 8 shows all the relative weights of factors.

When analysing the results, it can clearly be seen that when making large-scale investment decisions the quality of product has to be correct. When making strategic decisions, the concept of flexibility is marginal because the advantage of this has to be seen before the investment decision. Suppliers' answers are compatible with Kosonen's and Doz's points (2008). Suppliers' know-how makes it possible to react to investors' needs in a way that strategic sensitivity is taken into consideration and it also empowers collective commitment.

Figure 9 shows that total costs of investment are seen differently by suppliers and investors. Total costs are much more important to the investors than they are to the suppliers. This is naturally due to the fact that investors try to minimise the costs without affecting the quality. In general, the most important subfactor in total costs of investment is the Reliability of product.

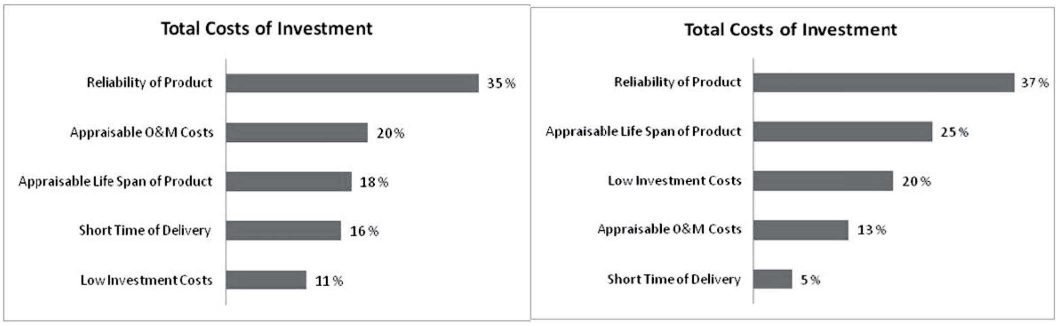
Dependable promises and product support are the two most important customer focus subfactors. Figure 10 shows all the relative weights of the customer focus subfactors.

Figure 8 Competitive priorities of investment strategy for wind power



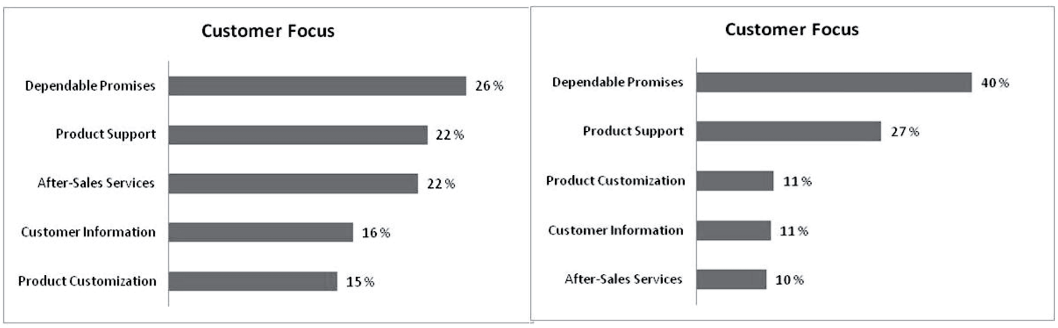
Note: Left chart: suppliers' answers, right chart: investors' answers.

Figure 9 Total costs of investment subfactors



Note: Left chart: suppliers' answers, right chart: investors' answers.

Figure 10 Customer focus subfactors



Note: Left chart: suppliers' answers, right chart: investors' answers.

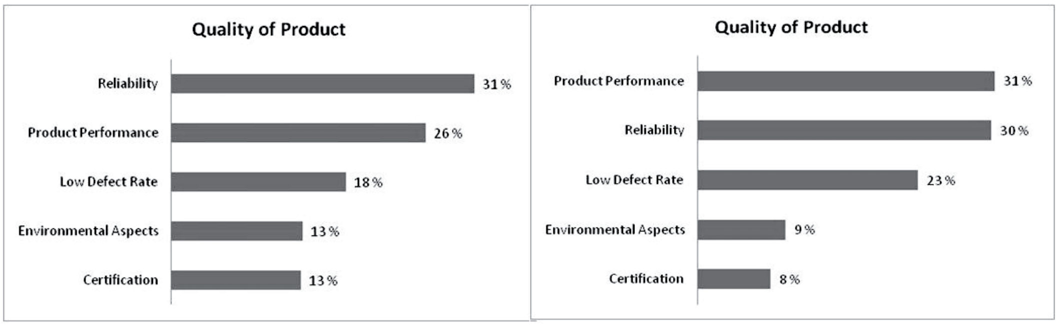
As can be seen in Figure 11, the most important subfactors in quality of product are reliability and product performance from both the suppliers' and investors' perspective. Certification as itself has not been considered important because the other features have to given answered state of the certification systems. It is controversial because the features of the product can be testified with certification.

It is worth noticing that the right quality of the product is by far the most important part of the Total delivery. Right quality means the quality that the supplier and the orderer have agreed on and the quality that gives the orderer benefits that match the price paid. Fast delivery has not been considered to be one of the top priorities. This is because the wind power industry investments are so large and capital intensive that the delivery time of a single product has not been considered to have significant importance. Figure 12 shows all the relative weights of the total delivery subfactors.

When making strategic investment decisions, flexibility is considered to be the least influential factor. The experts' point of views varied when they made comparisons of the most important subfactors. The only thing that they agree on is that the location does not give the factor pre-eminent compatible advantage. Figure 13 shows all the relative weights of the flexibility subfactors.

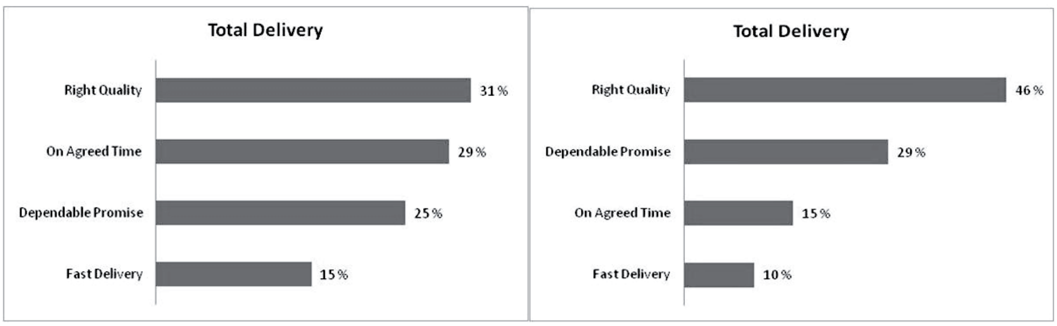
Figure 8 shows that supplier's know-how is a very important factor from the suppliers' point of view but not from the investors'. Figure 14 presents that the most important subfactors by far are the problem solving skills and R&D. In practice, problem solving skills help to find a solution to a problem and help to adjust the companies' strategies to meet the markets' weak signals.

Figure 11 Quality of product subfactors



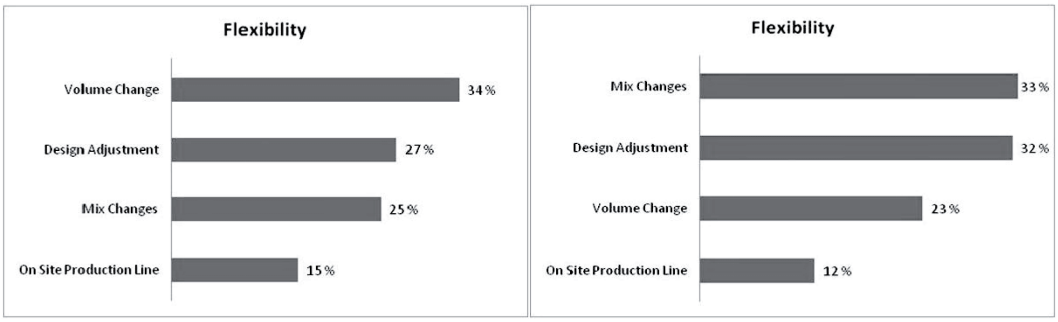
Note: Left chart: suppliers' answers, right chart: investors' answers.

Figure 12 Total delivery subfactors



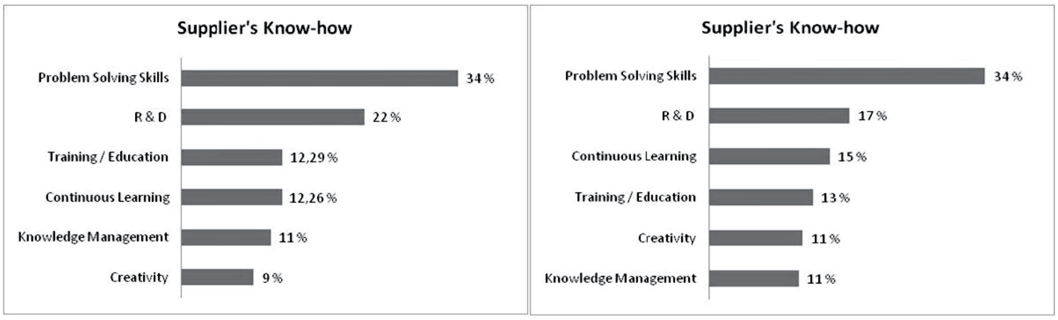
Note: Left chart: suppliers' answers, right chart: investors' answers.

Figure 13 Flexibility subfactors



Note: Left chart: suppliers' answers, right chart: investors' answers.

Figure 14 Supplier's know-how subfactors



Note: Left chart: suppliers' answers, right chart: investors' answers.

As Figure 14 shows, the most important subfactor in supplier's know-how is problem solving skills. Knowledge management and creativity are the least important factors for both the suppliers and investors.

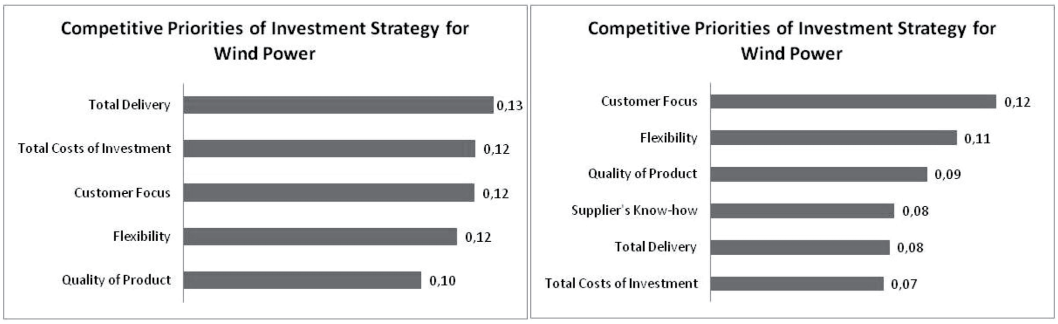
5 Evaluation of results and further research

The results of the AHP analysis method showed that some investors' and suppliers' expectations for the competitive priorities of investment strategies' main factors differ from each other. The reliability of the research has been raised by making an interview for some of the specialists who answered the AHP-questionnaire. The specialists' opinions did not change when they answered the main questionnaire and when they answered the additional questions in the interview. If all the specialists were personally interviewed, the results would have been more reliable. If more specialists were interviewed in the case companies and if the interviews were done several times, even higher validity of the results would have been achieved so that the results could be compared better to each other. The accuracy and reliability of the results can be raised if some other scientific method would be used alongside with AHP.

Inconsistency was calculated to assure the reliability of the pair-wise comparison results. Values under 0.2 are considered to be reasonably inconsistent as Hafeez et al. (2000) suggested. Bana e Costa and Vansnick (2008) are also analysed the role of AHP's inconsistency ratio. The inconsistency ratio of the answers was under 0.2 in every factor calculated by using the geometric mean value (see Figure 15).

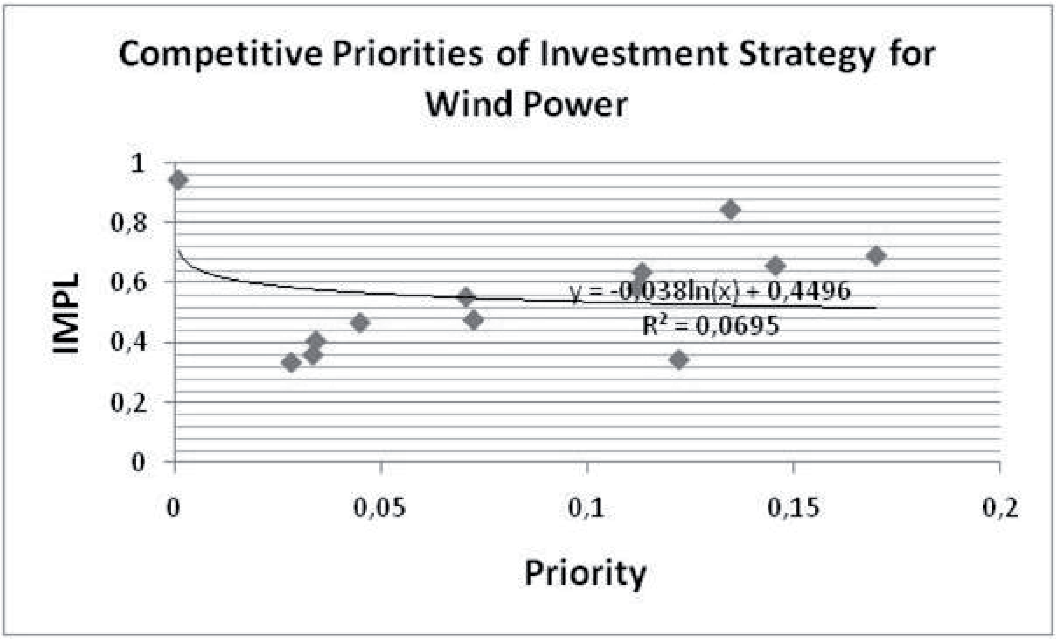
In order to gain opportunities to analyse and to enable better pair-wise comparison, Takala's (2000) IMPL was used in this study. According to Takala (2000), IMPL increases the sensitivity of the deviation in factors and improves the possibility to compare difficult cases to each other. The IMPL value is calculated by dividing the SD of an attribute assessment results by the value of the corresponding average value. All the IMPL values of this research are under one (<1), which means that the result of the research was reliable. Figure 16 presents the IMPL index of the competitive priorities of investment strategy for wind power.

Figure 15 The inconsistency ratio of the research result calculated by using the geometric mean value



Note: Left chart: suppliers' answers, right chart: investors' answers.

Figure 16 The implementation index of the competitive priorities of investment strategy for wind power



The inconsistency ratio of individual answers was more than 0.2, which shows that the specialists who answered the questionnaire categorised some of the factors inconsistent. This partly explains why the investors' and suppliers' point of views differ in some factors and why researches of this kind produce new information for the industry. The validity of the results of the AHP was tested by different statistical parameters and brainstorming. The results showed a high validity. Construction was tested by a weak market test in which the result was positive.

There are several topics for further study in the subject matter. The results of this research show the factors that the specialists consider being the most influential ones when planning strategic investments for wind power and, additionally, which are helpful when suppliers modify the companies' strategies to be more sensitive. The research should be deepened by finding out what real differences exist between the suppliers and investors. The research should also be deepened by finding out how suppliers could more specifically find answers to consistent strategic planning, to increase flexibility of resources and to raise collective commitment.

6 Conclusions

The objective of the research was to evaluate the major factors of decision-making process affecting investments made in wind power, especially in Finland, from the investors' and suppliers' point of view. The energy industry in Finland, and also in many other countries, is exceptional because of not only the limitations set by ownership and cost structure, but also limitations set by the official supervision and special technical features. The companies have to use complicated analysing methods when investing in wind power. The results based on the AHP also mainly give quantitative information of the weight value of the factors. The goals set for the research were achieved: the factors and subfactors affecting investment strategies in wind power industry were identified and analysed by using the AHP method. The results showed clearly that the important factors in investment decision-making process are found with the AHP model.

The research findings give the equipment suppliers a possibility to reform their strategies according to the factors that wind power investors appreciate. This is part of the strategic agility launched by Doz and Kosonen (2008). The theoretical part of the research consisted of the competitive priorities of investment strategy and AHP model theories. The additional objective was to compare investors' opinions with suppliers' opinions by using the RAL model. This work is linked to the existing scientific research.

The process will also help the suppliers to understand the investors' expectations. The results showed clearly that with the model the competitive priorities of investment strategy are found both from the investors' and suppliers' point of view.

The results of this research are a contribution to science because they fulfil the goal that was set for this research and its starting point lies on previous literature on the matter. A modified RAL model was created with a theory which has been tested with specialists of the wind power investors and suppliers. At the same time, industry's concepts are widened. In the future, it is obvious that certain changes are taking place in the industry and, therefore, the dynamic multi-criteria decision-making process will help in decision making and modifying strategies to be more sensitive.

References

Alberto, P. (2000) 'The logistics of industrial location decisions: an application of the analytic hierarchy process methodology', *Int. J. Logistics*, Vol. 3, pp.273–289.

Bana e Costa, C. and Vansnick, J. (2008) 'A critical analysis of the eigenvalue method used to derive priorities in AHP', *European Journal of Operational Research*, Vol. 187, pp.1422–1428.

COM (2007) *Commission of the European Communities, Communication from the Commission to the European Council and the European Parliament, An Energy policy for Europe*, Brussels, Commission of the European Communities.

Doz, Y. and Kosonen, M. (2008) *Fast Strategy: How Strategic Agility Will Help You Stay Ahead of the Game*. Great Britain, Wharton School Publishing.

Hafeez, K., Zhang, Y., Abdelmeguid, H., Malak, N. and Iqbal, S. (2000) 'Firm competence evaluation framework using AHP', *1st International Conference of System Thinking in Management*, pp.225–230.

International Energy Agency (2007) *Energy Statistics 2007*, Retrieved May 15, 2008. Available at: http://www.iea.org/statist/index.htm.

Kasanen, E., Lukka, K. and Siitonen, A. (1993) 'The constructive approach in management accounting research', *Journal of Management Accounting Research*, Vol. 5, pp.241–264.

Papler, D. and Bojnec, S. (2007) 'Electricity supply management for enterprises in Slovenia', *Int. J. Management and Enterprise Development*, Vol. 4, pp.403–414.

Saaty, T. (1977) 'A scaling method for priorities in hierarchical structures', *Journal of Mathematical Psychology*, Vol. 15, pp.234–281.

Saaty, T. (1980) *The Analytic Hierarchy Process: Planning, Priority, Resource Allocation*. New York, NY: McGraw-Hill.

Saaty, T. (1999) *Decision Making for Leaders* (3rd ed.). Pittsburgh, PA: RWS Publications.

Saaty, T. and Bennett, J. (1977) 'A theory of analytical hierarchies applied to political candidacy', *Behavioral Science*, Vol. 22, pp.237–245.

Saaty, T. and Mariano, R. (1979) 'Rationing energy to industries: priorities and input-output dependence', *Energy System Policy*, Vol. 3, No. 1, pp.85–111.

Takala, J. (2000) 'Analyzing and synthesizing multi-focused manufacturing strategies by analytic hierarchy process', *ICPQR 2000 The 9th International Conference on Productivity and Quality Research*, Israel, pp.25–28.

Takala, J. (2002) 'Analysing and synthesising multifocused manufacturing strategies by analytical hierarchy process', *Int. J. Manufacturing Technology and Management*, Vol. 4, pp.345–355.

Takala, J. and Toshev, R. (2007) 'Analyzing competitiveness of manufacturing and service operations – global benchmarking of cases from Slovenia and Slovakia', *Management International Conference 2007* (MIC'07).

The Advisory Council of the European Wind Energy Technology Platform (2006) *Wind Energy: A Vision for Europe in 2030*, Brussels, Belgium.

The European Wind Energy Association (2008) *European Statistics*, Retrieved July 20, 2008. Available at: http://www.ewea.org.

Varho, V. (2007) 'Calm or storm? – wind power actors' perceptions of Finnish wind power and its future', *Doctoral Dissertation*, University of Helsinki, Department of Biological and Environmental Sciences.

Int. J. Management and Enterprise Development, Vol. X, No. X, xxxx 1

The competitive priorities of the wind power investment

Tomi Mäkipelto

Department of Production,
University of Vaasa,
P.O. Box 700,
Vaasa FI-65101, Finland
E-mail: tomi.makipelto@student.uwasa.fi

Abstract: The goal of this research is to analyse the decision-making process and competitive priorities of investment strategies from wind power investors' point of view and to compare the findings with the opinions of wind power unit suppliers. The used research methodologies were an action analytical and a constructive case research. Empirical data were collected using the researcher's observations, including informal discussions and formal questionnaires. The results showed a considerable difference of opinion between investors and suppliers in making investment decision. That helps managers and executives to develop their enterprises.

Keywords: multi-criteria decision making; strategic management; enterprise development; energy industry; wind power.

Reference to this paper should be made as follows: Mäkipelto, T. (xxxx) 'The competitive priorities of the wind power investment', *Int. J. Management and Enterprise Development*, Vol. x, No. x, pp.xx–xx.

Biographical notes: Tomi Mäkipelto is a Postgraduate student in the University of Vaasa, Finland. He holds an MSc in Technology (major in Industrial Management) from the Tampere University of Technology (2005). His field of interest is investment decision process in the energy industry. His work experience includes being a Managing Director in several investment companies, with a focus on investment in wind farms in Finland (2007 to till date), Vice President in EPV Energy Ltd. (2008 to till date), a Development Manager in Etelä-Pohjanmaan Voima Oy (2006–2008) and an Expert (Business Economics) in Etelä-Pohjanmaan Voima Oy (2005–2006).

1 Introduction

Global warming would be one of the main challenges in the future. The main purpose of the Intergovernmental Panel on Climate Change (IPCC) is to produce extensive reports on the environmental situation, future prospects, the estimated effects of the climate change and research results on possible ways to prevent the climate change. IPCC reports are meant to produce meaningful scientific information to support decision making without suggesting certain political choices. A large group of leading experts in the world is included in the establishing process of the reports.

According to IPCC, warming of the climate system is unequivocal. The results of observations clearly show an evidence of increase in average global air and ocean temperatures, widespread melting of snow and ice and rising of average global sea level. About 11 years of the last 12 years (1995–2006) rank among the 12 warmest years in global surface temperature (since 1850). Most of the observed years showed an increase in global average temperatures since the mid-20th century. This is very likely because of the observed increase in anthropogenic greenhouse gas (GHG) concentrations (IPCC, 2007).

There are to actions in the plan or process to prevent the global warming. According to the climate change report (IPCC, 2007), particularly energy industry should focus on the following elements:

1 strengthening of overhead transmission and distribution infrastructure

2 underground cabling for utilities

3 energy efficiency

4 use of renewable sources

5 reduced dependence on single sources of energy.

In the European Union (EU), there is an agreement on the goals of climate and energy policies. In January 2007, EU Commission has given a notification concerning EU's energy and climate strategy, in which the goals of EU's integrated climate and energy policies are determined. In spring 2007, European council confirmed the target settings and in January 2008, the commission gave act propositions to restrict emissions and on the actions to promote renewable energy sources (COM, 2007a).

The main targets in EU's energy and climate strategy and in commission's act propositions are as follows (COM, 2007a):

1 The rise in average temperature should be restricted to 2°, which by 2050 requires a 50% cut from the 1990s level of GHG. For the industrial countries, this means 60–80% cut by 2050.

2 Based on a unilateral agreement, by 2020, EU's GHG will be reduced by at least 20% from 1990s level. This target is particularly challenging because EU countries' emissions have been growing in the last decades, and there are only 12 years left to the deadline. The cut down target rises to 30% if an international climate agreement is made. This would mean that all the industrial countries are committed to

    a similar cut downs as EU countries and developing countries, which have shown economical progression

    b to participate in the efforts as much as possible considering their resources and responsibilities.

3 The percentage of renewable energy sources of final energy consumption should rise from 8.5% (in 2005) to 20% by 2020.

4 At the same time, EU's goal is to improve energy efficiency, thereby reducing energy consumption by 20% by the year 2020, from when it would be without any actions. Energy efficiency target is not mandatory but directive.

The relative importance of renewable energy sources and controlling the climate change, guided by EU's targets, has risen in energy production portfolio. Rising the share of renewable energy sources from 8.5% (in 2005) to 20% by the year 2020 is going to demand considerable investments from the EU. This means large investments in energy production processes in the near future (COM, 2007a).

1.1 The future prospects of wind power

Globally as well as in Europe, building wind power is one of the most respectable ways to grow the share of renewable energy production. Energy payback time is reported to be decreasing considerably, with values around 6–8 months at the moment, which is similar to conventional energy, but with no ongoing fuel supply costs or waste production. The payback time for CO_2 is between 13 and 20 months, thus showing that the return on investment is rapid in terms of environmental and economic costs (COM, 2007b).

Challenges in building all forms of energy production facilities, including wind power, are very complex. While selecting the areas for wind power production, one has to balance between productivity and environmental values. On the one hand, fell areas would be ideal when it comes to productivity, but on the other hand, the wind power farms built on top of fell areas can be seen from kilometres away and are rather dominant in the environment. Wind power farms built on the coastal area hardly change the existing environment and have moderate wind.

Long-term profitability of investments made in wind power industry depends on the windiness of the area, the usability of wind power farms, investment and maintenance costs and also on the market price of electricity and the level of possible support systems.

This research explores the decision-making process of investments in wind power industry from investors' and suppliers' point of view. Analysing general acceptability factors, such as visual and sound impacts, are not being examined in this research topic. Although these factors are closely related to the investment as a whole, they are mainly examined before the actual decision-making process, as a part of the permission process.

1.2 The purpose of the research

The purpose of this research is to analyse the decision-making process and competitive priorities of investment strategies from wind power investors' point of view and to compare the findings with the opinions of wind power unit suppliers. In order to be able to analyse competitive priorities of the investment strategy, understanding the decision-making process is crucial. The enterprises can utilise these findings when constructing and modifying their strategies to be more sensitive.

This type of research could be carried out using a different form of energy production. The purpose of the research is to focus on a situation in which an energy industry investor has already chosen a particular form of energy production based on case-specific competitive priorities. Examples of case-specific competitive priorities include country-specific support and tax systems, which place different energy production forms in different positions depending on the legislative framework. Selection of a particular energy production form also makes it possible to compare energy industry investors with equipment suppliers using the method and level of examination employed in this research. This research complements, among others, the decision-making research on the strategic choices made by wind power investors carried out by Lee et al. (2009).

The study in question focused on China so that the data it produced would be comparable. The case section of this research is focused on Finland in order to be able to take the local energy industry framework into consideration and make the results comparable.

Wind power is one way to produce electricity. This research focuses on wind power because the decision-making process of investments differs from other production modes of energy. The differences are caused by different support and tax systems and by different technical features such as adaptability (see e.g. Holttinen, 2004). Wind power in technological scale (more than 2.5 MW, multi-megawatt class) is relatively new energy production mode. In a large scale, it has increased only in the 21st century in EU (see EWEA, 2009). Wind power is one way to achieve the goals set by EU for increasing renewable energy sources (see COM, 2007a). It is crucial that suppliers understand the needs of investors regarding the investment process, so that they can manage, improve and develop their enterprises. The findings of this research fulfil the international researches that, among other things, focus on impacts of different support systems in the home market from suppliers' point of view (see e.g. Lewis and Wiser, 2007).

The researchers are using methods in the multi-focused manufacturing strategies. Takala (2002) analysed, synthesised and implemented multi-focused competitive strategies empirically. The empirical part of this research was prepared using the responsiveness, agility and leanness (RAL) model quantification as the multi-focused manufacturing strategy methodologies. In this research, empirical data were collected using the researcher's observations, including informal discussions and formal questionnaires.

This research utilises the findings from previous researches. Among these previous researches, the main factors that have an effect on the energy sector investments' life cycle profits in Finland are both financial and political in energy industry in general (see Mäkipelto, 2009). When examining wind power in particular, the researcher has in his earlier researches also evaluated the major factors affecting the decision-making process of investments from the investors' and suppliers' point of views in Finland (see Mäkipelto and Takala, 2009).

In this research, an innovative and theoretically justified solution have been obtained to answer a practical problem. The research fulfils the researcher's previous findings by deeply analysing the results. The results have been tested with a weak market test. The approach is constructive, similar to early researches which link to this area (Kasanen et al., 1993).

The research method is an action research, in which the research is combined with existing theoretical knowledge and after that empirical results are compared with existing theory. The external validity of the dynamic decision-making model developed in the research has been tested with a 'weak' market test including a questionnaire for specialists in the industry. The internal validity of the model was tested with a new, alternative questionnaire for part of the specialists, using brainstorming method, and it was also compared by the inconsistency ratio (IR). The implementation index (IMPL) measures importance and pressure to improve.

The action research is traditionally qualitative. In this research, there are parts of both qualitative and quantitative research methods. In the qualitative part, the dynamic decision-making model is formed with analytic hierarchy process (AHP). In the quantitative part, a weak market test is made for the former model.

The energy industry is undergoing a major changing process. Due to this process, investments in production have significantly reduced during the last decade. Uncertainty has grown in the capital intensive, long-term energy production modes. Circumstances described above support the need for this research among the decision makers.

2 Methods

The methodology of the research is grounded in methods of decision making. In decision making, the prerequisites of success of investment projects become tangible. Decision making involves a problem, which should be solved in an optimal way. Often, it also involves an uncertainty about the end results produced by different solution alternatives. Rasmussen (1986) has divided decision making into three areas: skill-, rule- and knowledge-based. Skill-based action is subconscious and constant observation of the environment and reaction to normal stimuli without conscious action. In rule-based action, attention is focused on problems, which, however, can be solved with the help of already known rules and methods. In problematic situations in which skills or known rules are not sufficient, it is necessary to adopt the highest, conceptual level of data processing, decision making and problem solving, in which action is goal-oriented and knowledge-based (Rasmussen, 1986). Following Rasmussen's definition, this research examines decision-making situations that fulfil the criteria of knowledge-based decision making.

Part of decision making is to identify and choose essential values and weightings. Decision making is comparison of alternatives and search of an optimal solution (Hammond et al., 1999; Scott and LeBlanc, 1995). The set of problems examined in this research is multi-dimensional, and therefore multi-attribute decision-making methods are used. In multi-attribute decision making, there are various kinds of criteria, weighting coefficients and alternatives related to issues. Typically, different kinds of matrices are formed in multi-attribute decision making.

Cost-benefit analysis (CBA) is a technique used worldwide in multi-attribute decision making. CBA evaluates the costs and benefits of different alternatives on a monetary basis. Typically, CBA is used to analyse the relation of different environmental impacts to costs (Boardman et al., 1996). Due to its economic emphasis, the method cannot be applied directly to this research. Elementary methods, on the other hand, are straightforward and can be used in cases in which complex calculations are of no significant help (Linkov et al., 2004). Examples of elementary methods include the pros and cons analysis, which can be easily implemented in decision making. In the qualitative comparison method, pros are compared with cons with respect to different alternatives (Linkov et al., 2004). In cases in which all the criteria are comparable, it is possible to utilise the maximin method. The maximin method is based on a strategy that tries to avoid the worst possible performance, maximising the minimal performing criterion (Linkov et al., 2004). In general, the methods described above can be used in cases in which different alternatives are compared with one another in order to find an optimal solution.

The third group of decision-making methods is based on the multi-attribute utility theory (MAUT). In these methods, different alternatives are given weighting coefficients multi-dimensionally. The most simple of MAUT methods is SMART, in which each criterion is given a weighting coefficient, with the help of which the criteria can be categorised (Hooks and Farry, 2001). In addition, there is the AHP proposed by Saaty (1980). The basic idea of the approach is to convert subjective assessments of relative importance to a set of overall scores or weights. AHP is one of the more widely applied multi-attribute decision-making methods. AHP is a powerful and flexible decision-making process that helps in prioritising and in decision making, where both the qualitative and quantitative aspects of the decision need to be considered. AHP is a multi-attribute decision instrument and its goal is to integrate different measures into single overall score for ranking decision alternatives with pairwise comparisons of the chosen attributes.

The AHP model is a decision-making framework that assumes one-way hierarchical relationship among different decision-making levels. The AHP model has three basic steps (Saaty 1980, 1999):

1 Development of a decision hierarchy: the top element of the hierarchy is the overall goal for the decision model. The hierarchy is a type of system where one group of factors influences another set of factors.

2 Pairwise comparisons are conducted to estimate the relative importance weights (or allocations) of the various elements on each level of the hierarchy.

3 The weights obtained are integrated to develop an overall ranking of decision alternatives.

The structure of the AHP method helps to recognise the factors affecting decision making more accurately and, in addition, it helps to acknowledge the mutual correlation between each factor. AHP makes it possible to combine accurate, measurable knowledge (costs, interest rates and measures) with intuition and personal valuations within the same decision-making model.

The AHP model is based on three principles:

1 decomposition of the decision problem

2 comparative judgement of the elements

3 synthesis of the priorities.

The results of this research could be analysed with the help of several different methods. The AHP was chosen as the primary method due to its multi-dimensional and comprehensive nature.

The AHP model was created using the RAL concept and the special characteristics of the energy industry (Takala, 2002). Creating the hierarchy was conducted by observations of the researcher, which have been completed with the views of the industry's specialists.

This research links to the strategic process. Forming the AHP hierarchy and analysing the results of this research approach the field of strategic decision-making proc1ess and operation management. According to Doz and Kosonen (2007, 2008a,b), companies should form their strategies to be more flexible and strategic decisions should be agile. It should be possible to reform the companies' strategies continuously: weekly, daily or even hourly. The main components of strategic agility are strategic sensitivity, resource fluidity and collective commitment.

The meaning of strategic sensitivity is both the sharpness of perception and the intensity of awareness and attention. Resource fluidity means the internal capability to reconfigure business systems and redeploy resources rapidly. Collective commitment means the ability of the top team to make bold decisions fast.

Strategic agility and the related ways of action in management process can be interpreted through companies' whole strategy, or the results of this model can be a strategic objective of single parts of the whole company. In this research, an investment decision is seen as an individual project which needs its own strategy so that important main and subfactors at the time of the investment can be realised. We need strategic agility in order to be able to guide our actions with production modes that have long life cycle (more than 20 years) within the changing framework.

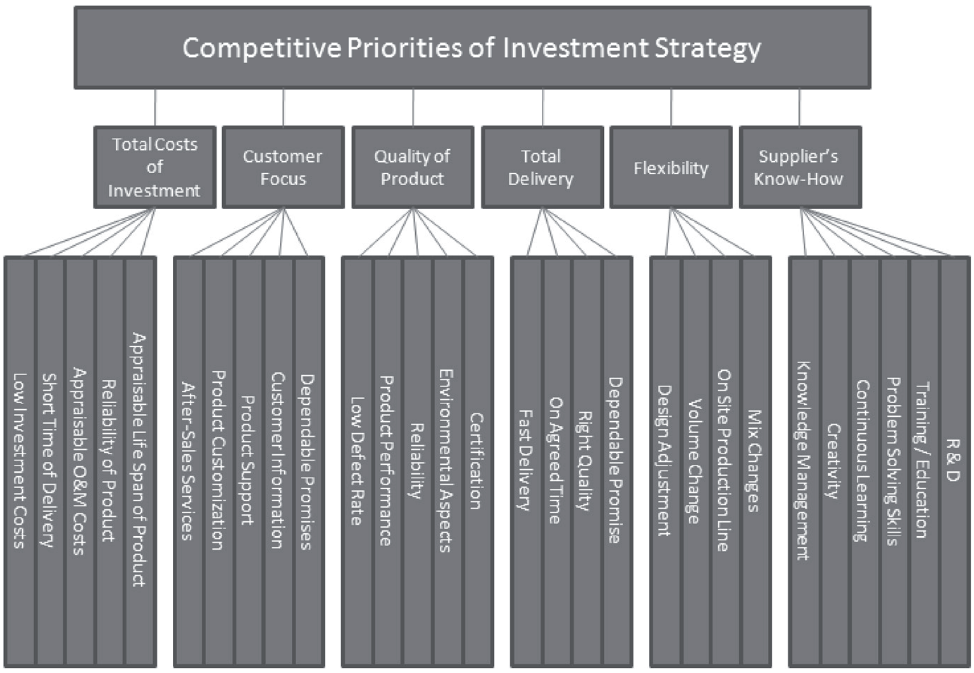
3 Modified AHP model

The AHP model has been modified to explore the investment decisions made in the wind power industry. The hierarchy is based on the discussions engaged with the experts in the industry. The modified AHP model gives the most relevant and comparable results for the research. Both energy fields, investors' and equipment suppliers' points of views have been taken into account when forming the hierarchy. Figure 1 shows the modified hierarchy for this research.

With the AHP model, the research findings give information which helps to control the strategic sensitivity of the company. The six main criteria which were chosen to be compared with the hierarchy model were the total costs of investment, customer focus, the quality of the product, total delivery, flexibility and supplier's know-how.

The research was carried out using a formal questionnaire, which is included in Appendix. The formal questionnaire enabled the collection of data in a systematic manner.

Figure 1 Modified AHP model



4 Results and analysis

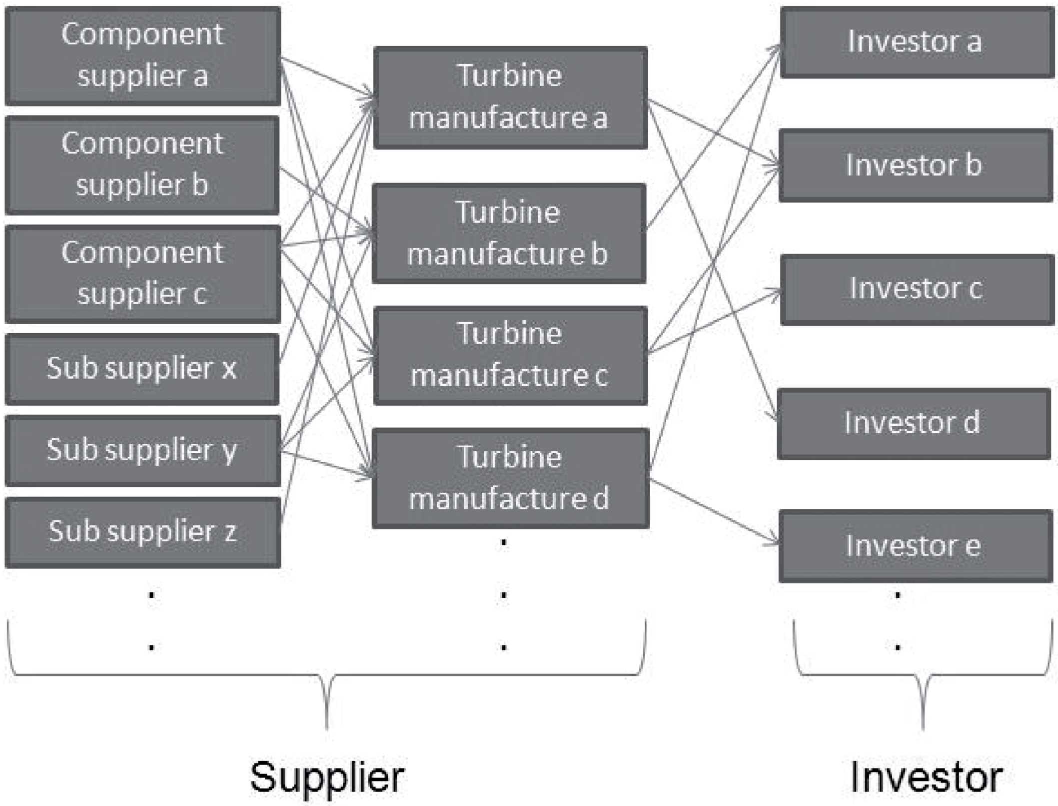
The results of AHP were similar despite the fact that the interviewees represented various specialists in the industry, i.e. both investors and suppliers. Relative importance of each of the examined main factors showed consensus with the most important factors.

The main suppliers of wind power plants act in close cooperation with sub- and/or component suppliers (see Figure 2). Main suppliers utilise several different subsuppliers/component suppliers when manufacturing their own products, and many different main suppliers utilise the products of the same sub- and component suppliers. Similar network also exist within the largest companies.

According to this research, a part of the subsuppliers operates with an original design manufacturer (ODM) principle. ODM is a company which manufactures a product which ultimately will be branded by another firm for sale. Such companies allow the brand firm to produce (either as a supplement or solely) without having to engage in the organisation or running of a factory. ODMs have grown in size in recent years and many are now sufficient in size to handle production or multiple clients, often providing a large portion of overall production. This model is especially used in international trade, where a local ODM is used to produce goods for a foreign company which sees some advantage in the transaction (such as low labour inputs, transport links, proximity to markets, etc.).

A primary attribute of this business model is that the ODM owns and/or designs in-house the products that are branded by the buying firm.

Figure 2 Network of wind power sector



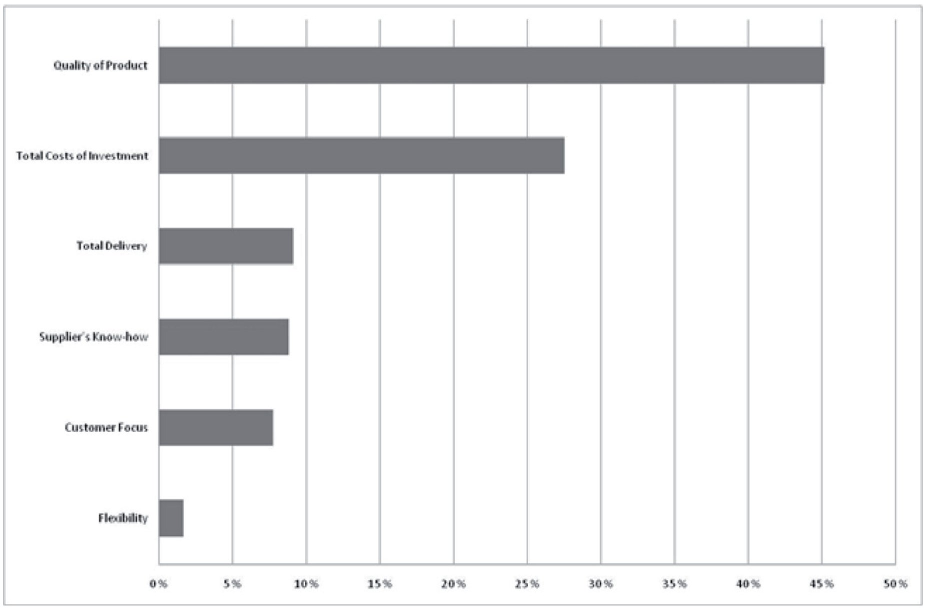
4.1 The main factor results and analysis

The data that were used in the research have been collected from the experts in the industry in Finland. The wind power industry is relatively small in Finland because the country has a very small amount of wind power compared to the EU level. The data consist of investors' and wind power suppliers' answers to the questionnaire. The participants in the research were 12 decision makers in the industry, who operate in significant positions in the target area of the research. Due to the limited nature of the industry, the number of participants was considered sufficient. These answerers are part of the investment process either as an investor or as a supplier. Data have been collected using a questionnaire (Appendix), and the results have been analysed with the help of AHP method and spreadsheet program.

In the research results, the suppliers' and investors' opinions are compared with each other. The opinions of suppliers and investors differ from each other in main factors. The results also show that investors clearly emphasise the two main factors, quality of product and total costs of investment. Respectively suppliers value all the factors almost equal. This partly explains that suppliers do not know what investors consider to be most important when making investment decisions. There are also some similarities between investors and suppliers: both consider flexibility factor to have only minor importance. This can be interpreted so that both investors and suppliers wish the contractual relation to be as stable and predictable as possible.

When calculating the relations between the differences in suppliers' and investors' opinions and counting the absolute values of importance rates of investors' answers, two main factors can be seen. Figure 3 shows that quality of product and total costs of investment factors are the ones where the opinions differs the most. In other words, suppliers should especially concentrate on these factors relative to competitors, so that they can increase their relative competitive advantage in relation to other suppliers.

Figure 3 Relative differences of investors and suppliers in each factor



As it can be seen in Figure 3, quality of product and total costs of investment explain more than 70% of relative differences and other factors together explain only 30%. By far, the largest (45%) difference in opinion is in the quality of product. Investors hold the factor relatively much more important than suppliers.

4.2 The main subfactor results and analysis

When reviewing the subfactors, it can be seen that there is the same division that can also be seen in main factors: investors have a clearer view on what are the most important subfactors than suppliers do. While analysing subfactors, the weighting coefficients of main factors have also been taken into consideration. On the one hand, while analysing the most important subfactors, it can be seen that from suppliers' point of view six most important factors explain 35% of the wholeness. On the other hand, when viewing investors' opinions it can be seen that six most important factors explain 50% of the whole. It is also remarkable that three factors (low investment costs, appraisable life span of product and low defect rate) that investors consider to be important are less important when suppliers are asked their opinions.

Calculating the relations between suppliers' and investors' opinions in each subfactor and counting the absolute values of importance rates of investors' answers, six main factors can be found. Figure 4 shows the six factors and they are as follows:

1 product performance

2 low defect rate

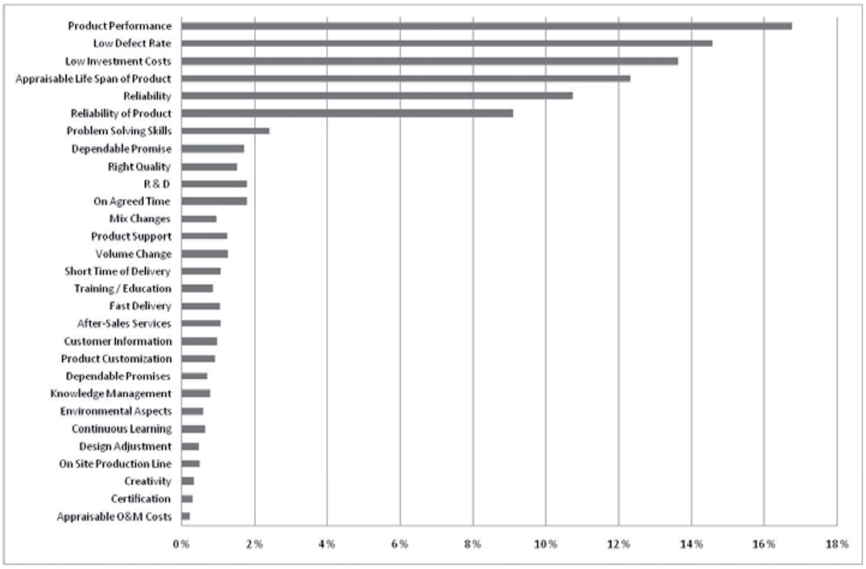
3 low investment costs

4 appraisable life span of product

5 reliability

6 reliability of product.

Figure 4 Relative differences in each subfactor between investors and suppliers



In these subfactors, the differences in opinions between suppliers and investors are the largest. In other words, supplier enterprises executives should specially concentrate on these factors when differentiating and aspiring to achieve competitive advantage in relation to their competitors.

It can be seen in Figure 4 that six subfactors explain more than 75% of relative differences and rest of the factors explain only less than 25%. In other words, 75% on relative differences in opinions forms from 21% of the subfactors.

5 Evaluation of results and further research

The results of the analysis clearly showed that some investors' and suppliers' expectations for the competitive priorities of wind power investment main factors (two) and subfactors (six) differ from each other. The reliability of the research has been increased by organising an interview for some of the specialists who answered the formal questionnaire. The specialists' opinions did not change when they answered the main questionnaire and when they answered the additional questions of the interviews. The specialists' opinions are also the same after brainstorming sessions. If all the specialists were personally interviewed, the results would have been more reliable. If more specialists were interviewed in the case companies and if the interviews were done several times, even higher validity of the results would have been achieved so that the results could be compared better to each other. The accuracy and reliability of the results could be increased if some other scientific method is used alongside with AHP.

Inconsistency was calculated to assure the reliability of the pairwise comparison results. Values below 0.2 are considered to be reasonably inconsistent as Hafeez et al. (2000) suggested. Bana e Costa and Vansnick (2008) also analysed the role of AHP's IR. The IR of the answers was below 0.2 in every factor calculated using the geometric mean value (see Figure 5).

To gain opportunities to analyse and to enable better pairwise comparison, Takala's (2000) IMPL was used in this study. According to Takala (2000), IMPL increases the sensitivity of the deviation in factors and improves the possibility to compare difficult cases to each other. The IMPL value is calculated by dividing the standard deviation of an attribute assessment results by the value of the corresponding average value. All the IMPL values of this research are below one (<1), which means that the result of the research was reliable. Figure 6 presents the IMPL index of the competitive priorities of the wind power investment.

The IR of individual answers was more than 0.2, which shows that the specialists who answered the questionnaire categorised some of the factors inconsistent. The validity of the results was tested by different statistical parameters and brainstorming. The results showed a high validity. Construction was tested by a weak market test in which the result was positive.

Figure 7 demonstrates the most important factors that had the largest distinctions between investors' and suppliers' answers. It is crucial to succeed in these factors so that the profitability of the investment is guaranteed. The investment situation is challenging because investments made in energy industry have exceptionally long life cycles (more than 20 years) and low percentages for return on investments.

Figure 5 IR of the research result calculated using the geometric mean value

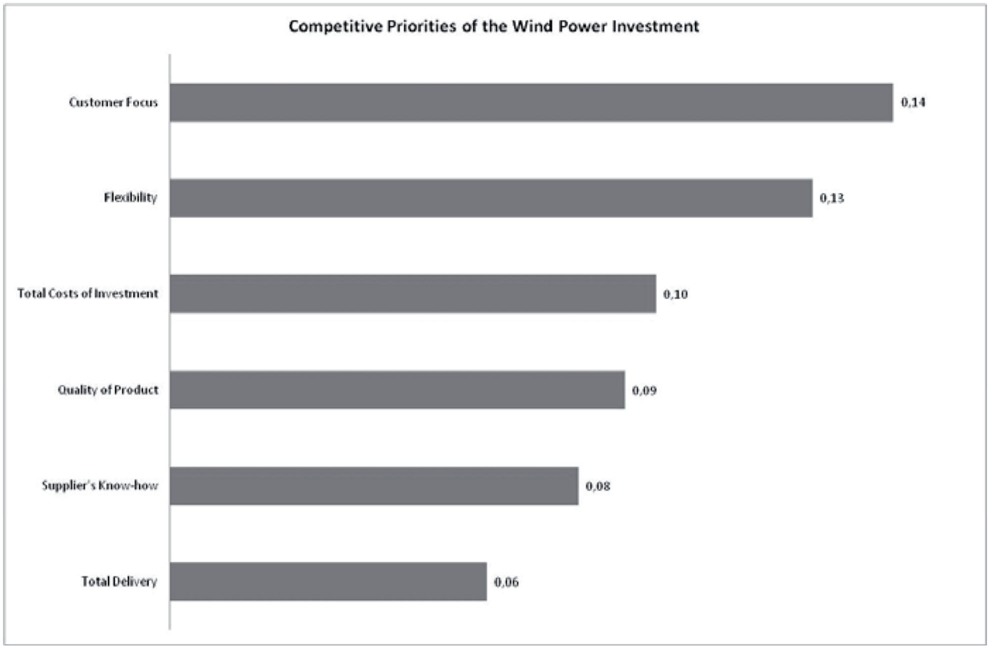


Figure 6 The IMPL index of the competitive priorities of investment strategy for wind power

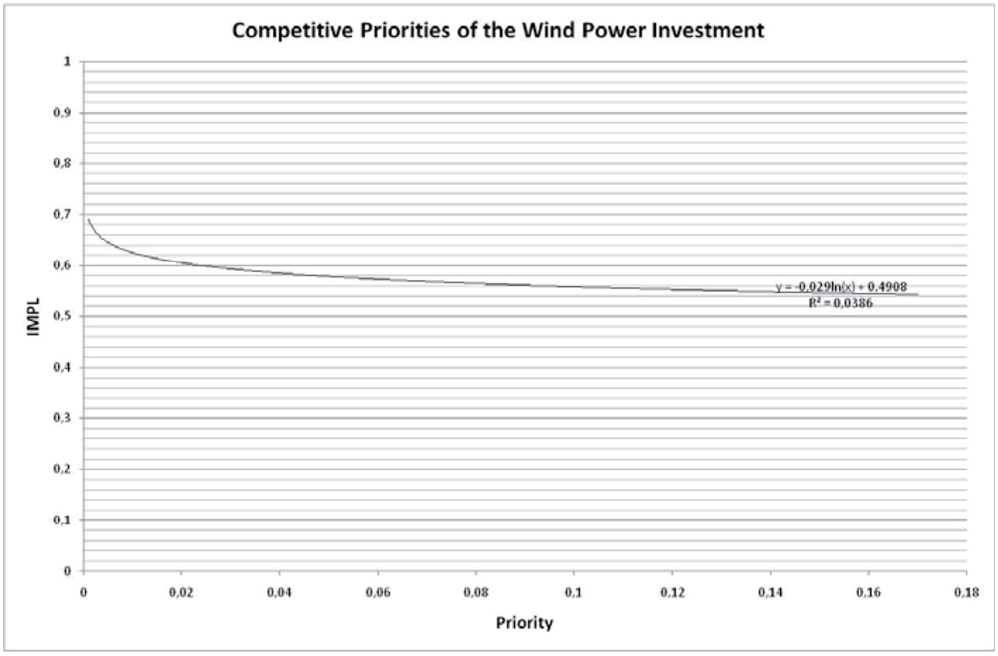
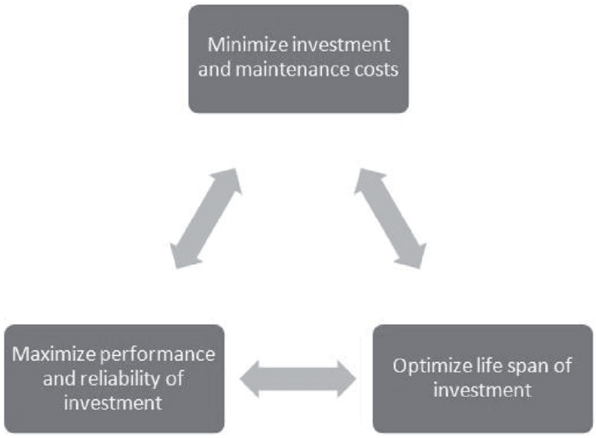


Figure 7 The relation of factors influencing the profitability of investment in time *n*



This research has been focused in time *n*. In the continuous change of frame of reference, the meaning of strategic leadership becomes especially important so that the continuous competitive advantage is achieved. The actor has to be able to control and develop the investments (production plant) to the right direction (where?) and in the right way (with that and how?). These questions can be answered with the elements of strategic agility launched by Doz and Kosonen (2007, 2008a,b). Strategic sensitivity answers the question where, resource fluidity tells us with what and collective commitment has the answer to the question how.

Examining the results of this research in international context, it can be seen that they are in concurrence with scientific data. In the research by Lee et al. (2009), the performance, business drivers and socioeconomic needs of a wind power project were compared with one another using similar methods. Based on the case study carried out in China, the research suggests that business drivers dominate decision making compared to performance and socioeconomic needs.

There are several topics for further study in the subject matter. The results of this research show the factors that the specialists consider being the most influential ones when investors plan to make strategic investments for wind power and the factors that are helpful when suppliers modify the companies' strategies. The results show the most important factors that deviate from the suppliers' expectations and which have an effect on investment decisions from investors' point of view.

The research should be widened by analysing how the investment can be developed in the future. The research should also be deepened by analysing the decision-making process and similarities in competitive priorities of other energy production methods.

6 Conclusions

The objective of the research was to analyse the decision-making process and competitive priorities of investment strategies from wind power investors' point of view and to compare the findings with the opinions of wind power unit suppliers' point of view in Finland. The companies have to use complicated analysing methods when investing in wind power.

The goals set for the research were achieved: the factors and subfactors affecting investment strategies in wind power industry are analysed using the AHP method and the brainstorming. The results clearly showed that the important factors in investment decision-making process and strategy analyses are found with the AHP model. Despite the limited nature of expert answers, the research clearly reveals the most important factors at play within the geographical research area.

Calculating the relations between suppliers' and investors' opinions in each subfactor and counting the absolute values of importance rates of investors' answers, six main factors can be found. Those six factors are: product performance, low defect rate, low investment costs, appraisable life span of product, reliability and reliability of product. In these subfactors, the differences in opinions between suppliers and investors are the largest. On the other hand, suppliers' and investors' opinions are almost same when they analyse importance of creativity, certification and appraisable O&M costs factors to each other.

The research findings give the equipment supplier executives a possibility to reform and develop their strategies according to the factors that wind power investors appreciate, and the research findings also give the investors a possibility to find the most important factors when they modified strategies. This work is linked to the existing scientific research.

The process also helps the supplier enterprises executives to understand the investors' expectations and on the other hand helps the investors to clarify the most important factor in the decision-making situation. The results showed clearly that with the model, the competitive priorities of investment strategy are found and analysed both from the investors' and suppliers' point of view.

As a subject for further research, this research could be extended by including all enterprises operating in the wind power industry, carrying out the study in other geographical areas or examining other forms of energy production. With respect to investment decisions, energy production methods differ as to their earnings logics and technological implementation models. Another subject for further research would be to extend the research to other kinds of investment decision situations. It would also be possible to study and compare the investment decision situations related to different energy production forms or to examine different equipment suppliers' investment decision situations in a more detailed way.

The results of this research are a contribution to science because they fulfil the goal that was set for this research, and its starting point lies on previous literature on the matter. This work links also to the existing scientific research. A formerly created AHP model results were analysed and tested with specialists of the wind power sectors' investors and suppliers. At the same time, industry's concepts are widened. In the future, it is obvious that certain changes are taking place in the industry and, therefore, the dynamic multi-criteria decision-making process will help decision makers modify their strategies to be more agile.

References

Bana e Costa, C. and Vansnick, J. (2008) 'A critical analysis of the eigenvalue method used to derive priorities in AHP', *European Journal of Operational Research*, Vol. 187, pp.1422–1428.

Boardman, A.E., Greenberg, D.H., Vining, A.R. and Weimer, D.L. (1996) *Cost Benefit Analysis: Concepts and Practice*. New Jersey: Prentice Hall.

COM (2007a) *Commission of the European Communities, Communication from the Commission to the European Council and the European Parliament: An Energy Policy for Europe*. Brussels: Commission of the European Communities.

COM (2007b) *Science for Environment Policy: Wind Energy-Status and Trends*. Brussels: Commission of the European Communities.

Doz, Y. and Kosonen, M. (2007) 'The new deal at the top', *Harvard Business Review*, Vol. 6, pp.98–104.

Doz, Y. and Kosonen, M. (2008a) *Fast Strategy: How Strategic Agility Will Help You Stay Ahead of the Game*. Great Britain: Wharton School Publishing.

Doz, Y. and Kosonen, M. (2008b) 'How agile is your strategy process?', *Strategy Magazine*, Vol. 15, pp.6–10.

EWEA (2009) *Pure Power 2009 – Wind Energy Targets for 2020 and 2030*, A report by the European Wind Energy Association – 2009 update.

Hafeez, K., Zhang, Y., Abdelmeguid, H., Malak, N. and Iqbal, S. (2000) 'Firm competence evaluation framework using AHP', *1st International Conference of System Thinking in Management*.

Hammond, J., Keeney, R. and Raiffa, H. (1999) *Smart Choices, A Practical Guide to Making Better Decisions*. Boston: Harvard Business School Press.

Holttinen, H. (2004) 'The impact of large scale wind power production on the Nordic electricity system', Doctoral Dissertation, Espoo: VTT Processes, VTT Publications, p.554.

Hooks, I. and Farry, K. (2001) *Customer Centered Products – Creating Successful Products through Smart Requirements Management*. New York: American Management Association.

IPCC (2007) *Climate Change 2007: Synthesis Report, An Assessment of the Intergovernmental Panel on Climate Change. Geneva, Intergovernmental Panel on Climate Change.*

Kasanen, E., Lukka, K. and Siitonen, A. (1993) 'The constructive approach in management accounting research', *Journal of Management Accounting Research*, Vol. 5, pp.241–264.

Lee, A., Chen, H. and Kang, H-Y. (2009) 'Multi-criteria decision making on strategic selection of wind farms', *Renewable Energy*, Vol. 34, pp.120–126.

Lewis, J. and Wiser, R. (2007) 'Fostering a renewable energy technology industry: an international comparison of wind industry policy support mechanisms', *Energy Policy*, Vol. 35, pp.1844–1857.

Linkov, I., Varghese, A., Jamil, S., Seager, T.P., Kiker, G. and Bridges, T. (2004) 'Multi-criteria decision analysis: a framework for structuring remedial decisions at the contaminated sites', *Comparative Risk Assessment and Environmental Decision Making*, New York: Springer.

Mäkipelto, T. (2009) 'Competitive priorities of investment strategy: case wind power', *Int. J. Sustainable Economy*, Vol. 1, pp.388–402.

Mäkipelto, T. and Takala, J. (2009) 'The model based on the analytic hierarchy process for dynamic decision making in the energy industry: a case analysis of investment energy production in Finland', *Int. J. Nuclear Governance, Economy and Ecology*, Vol. 2, pp.281–295.

Rasmussen, J. (1986) *Information Processing and Human–Machine Interaction: An Approach to Cognitive Engineering*. New York: North-Holland.

Saaty, T. (1980) *The Analytic Hierarchy Process: Planning, Priority, Resource Allocation*. New York: McGraw-Hill.

Saaty, T. (1999) *Decision Making for Leaders* (3rd ed.), Pittsburgh, PA: RWS Publications.

Scott, F. and LeBlanc, S. (1995) *Strategies for Creative Problem Solving*. New Jersey: Prentice-Hall.

Takala, J. (2000) 'Analyzing and synthesizing multi-focused manufacturing strategies by analytic hierarchy process', *ICPQR 2000 The 9th International Conference on Productivity and Quality Research*, Israel, pp.25–28.

Takala, J. (2002) 'Analysing and synthesising multifocused manufacturing strategies by analytical hierarchy process', *Int. J. Manufacturing Technology and Management*, Vol. 4, pp.345–355.

The Competitive Priorities of the Wind Power Investment

Appendix 1

Quality of Product

	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	
Low Defect Rate		Product Performance
Low Defect Rate		Reliability
Low Defect Rate		Environmental Aspects
Low Defect Rate		Certification
Product Performance		Reliability
Product Performance		Environmental Aspects
Product Performance		Certification
Reliability		Environmental Aspects
Reliability		Certification
Environmental Aspects		Certification
	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	

Total Delivery

	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	
Fast Delivery		On Agreed Time
Fast Delivery		Right Quality
Fast Delivery		Dependable Promises
On Agreed Time		Right Quality
On Agreed Time		Dependable Promise
Right Quality		Dependable Promise
	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	

Flexibility

	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	
Design Adjustment		Volume Change
Design Adjustment		On Slte Production Line
Design Adjustment		Mix Changes
Volume Change		On Slte Production Line
Volume Change		Mix Changes
On Slte Production Line		Mix Changes
	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	

Supplier's Know-how

	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	
Knowledge Management		Creativity
Knowledge Management		Continuous Learning
Knowledge Management		Problem Solving Skills
Knowledge Management		Training / Education
Knowledge Management		R & D
Creativity		Continuous Learning
Creativity		Problem Solving Skills
Creativity		Training / Education
Creativity		R & D
Continuous Learning		Problem Solving Skills
Continuous Learning		Training / Education
Continuous Learning		R & D
Problem Solving Skills		Training / Education
Problem Solving Skills		R & D
Training / Education		R & D
	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	

Quality of Product

	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	
Low Defect Rate	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Product Performance
Low Defect Rate	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Reliability
Low Defect Rate	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Environmental Aspects
Low Defect Rate	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Certification
Product Performance	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Reliability
Product Performance	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Environmental Aspects
Product Performance	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Certification
Reliability	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Environmental Aspects
Reliability	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Certification
Environmental Aspects	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Certification
	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	

Total Delivery

	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	
Fast Delivery	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	On Agreed Time
Fast Delivery	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Right Quality
Fast Delivery	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Dependable Promises
On Agreed Time	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Right Quality
On Agreed Time	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Dependable Promise
Right Quality	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Dependable Promise
	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	

Flexibility

	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	
Design Adjustment	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Volume Change
Design Adjustment	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	On SIte Production Line
Design Adjustment	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Mix Changes
Volume Change	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	On SIte Production Line
Volume Change	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Mix Changes
On SIte Production Line	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Mix Changes
	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	

Supplier's Know-how

	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	
Knowledge Management	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Creativity
Knowledge Management	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Continuous Learning
Knowledge Management	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Problem Solving Skills
Knowledge Management	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Training / Education
Knowledge Management	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	R & D
Creativity	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Continuous Learning
Creativity	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Problem Solving Skills
Creativity	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Training / Education
Creativity	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	R & D
Continuous Learning	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Problem Solving Skills
Continuous Learning	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Training / Education
Continuous Learning	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	R & D
Problem Solving Skills	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	Training / Education
Problem Solving Skills	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	R & D
Training / Education	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	R & D
	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	

Int. J. of Management and Enterprise Development, Vol. x, No. x, xxxx

The Fast Strategy and Dynamic Decisions in Energy Industry

Tomi Mäkipelto*

University of Vaasa
Department of Production
BO.Box 700, FI-65101 Vaasa, Finland
E-mail: tomi.makipelto@student.uwasa.fi
*Corresponding author

Kongkiti Phusavat

Kasetsart University
Department of Industrial Engineering
Bangkok 10900, Thailand
E-mail: fengkkp@ku.ac.th

Abstract: The main goal of the research was to link together different strategic models and then modify the special agility strategy model for energy industry. The sub goal was to analyze competitive priorities of the energy investments.

The used research methodologies were an action analytical and a constructive case research. Empirical data was collected by using researcher's observations, including informal discussions and using earlier scientific research results. The research findings give the investors a possibility to reform their strategies to be more sensitiveness way and the same time make own fast & dynamic decision model.

Keywords: dynamic decision; emerging strategic issues; strategy management; fast strategy; sense and response; enterprise development; energy industry.

Reference to this paper should be made as follows: Mäkipelto, T. and Phusavat, K. (201x) 'The Fast Strategy and Dynamic Decisions in Energy Industry', *Int. J. of Management and Enterprise Development*, Vol. x, No. x, pp.xx–xx.

Biographical notes: Tomi Mäkipelto is a postgraduate student in the University of Vaasa in Finland. He holds an MSc in Technology (major in Industrial Management) from the Tampere University of Technology (2005). His field of interest is the investment decision process in the energy industry. His work experience background includes being a Managing Director in several investment companies, focus on investment in windfarms in Finland (2007–present), Vice President in EPV Energy Ltd. (2008–present), a Development Manager in Etelä-Pohjanmaan Voima Oy (2006–2008) and an Expert (Business Economics) in Etelä-Pohjanmaan Voima Oy (2005–2006).

Kongkiti Phusavat is an Associate Professor and Director of International Graduate Programme in Industrial Engineering, Department of Industrial Engineering, Kasetsart University. He received his doctoral degree in Industrial and Systems Engineering from the Virginia Tech in 1995. His current research interests include systems engineering, performance measurement and acquisition logistics.

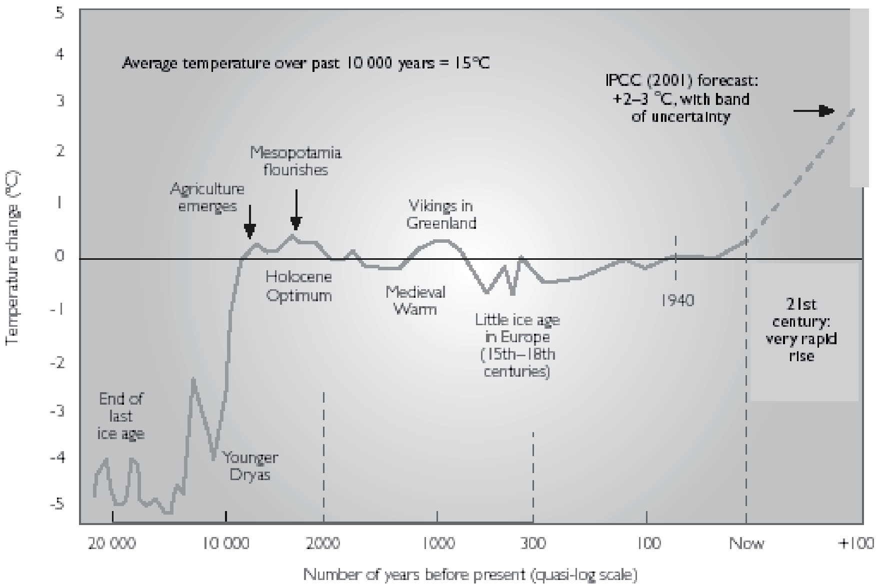
---

1 Introduction

Climate change is due to the growth in GHG emissions which is a consequence of human actions. The gases hold the sun's thermal radiation on the surface of the earth and thereby rise the average temperature on earth. The rise in temperature also affects on the cycle of the energy and substance on earth. The average temperature on earth also changes naturally but the speed of the current change is exceptional.

According to World Health Organization’s Climate change and human health -risks and responses report (World Health Organization, 2003) our increasing understanding of climate change is transforming how we view the boundaries and determinants of human health. While our personal health may seem to relate mostly to prudent behaviour, heredity, occupation, local environmental exposures, and health-care access, sustained population health requires the life-supporting "services" of the biosphere. Populations of all animal species depend on supplies of food and water, freedom from excess infectious disease, and the physical safety and comfort conferred by climatic stability. The world’s climate system is fundamental to this life-support. In Figure 1 it can be seen how Earth's average surface temperature has been variating over the past 20 000 years.

Figure 1 Variations in Earth’s average surface temperature, over the past 20 000 years



Source: World Health Organization (2003)

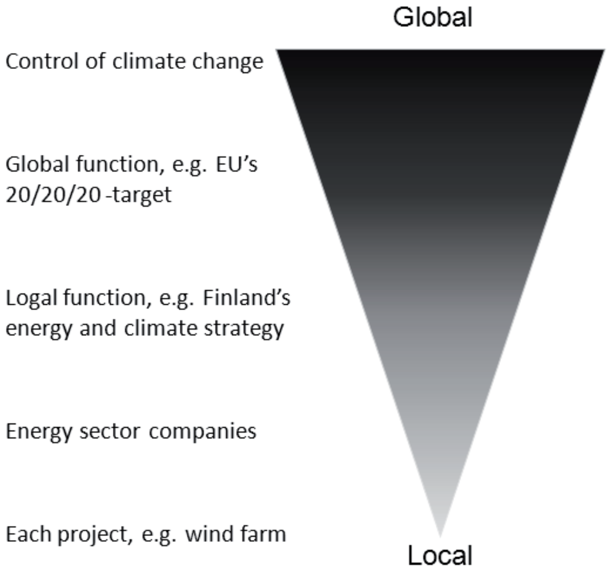
Respectively human nature needs energy (electric and heat energy) in order to produce the necessary life supporting "services". According to IPCC’s (Intergovernmental Panel on Climate Change, 2007) professionals connection between the global warming and the greenhouse gas (GHG) emissions are obvious. The largest growth in GHG emissions in the last decades has come from energy industry and transport. On the first hand, those two sectors are the biggest GHG emission producers (example CO2) and, on the other hand, they are the key players to put a damper on the growth of GHG emission. Under these circumstances the energy production plants will hold the key position in controlling the climate change and thereby its consequences.

Controlling the climate change is a global challenge. The fact that the problem is global but the solutions are local complicates rising to the challenge. Local solutions have

The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry

their own consequences and thereby solving the global problem requires sacrifices at local level. Often the benefits of these sacrifices are less concrete than the disadvantages or consequences are (Bosetti et al., 2009). As a concrete example of this is wind power. From sustainable development and readiness of technology point of views wind power is one of the economical ways to produce energy. From global point of view it is possible to produce energy in a sustainable way but locally it is not that simple: there are natural resources in every area and these resources can be disturbed from building or from the action of wind power (Bergmann et al., 2006 and Moran and Sherrington, 2007). Figure 2 illustrates the complicated relation between the global problem and the single solutions to that problem.

Figure 2 The complicated relation between climate change and the ways to prevent it

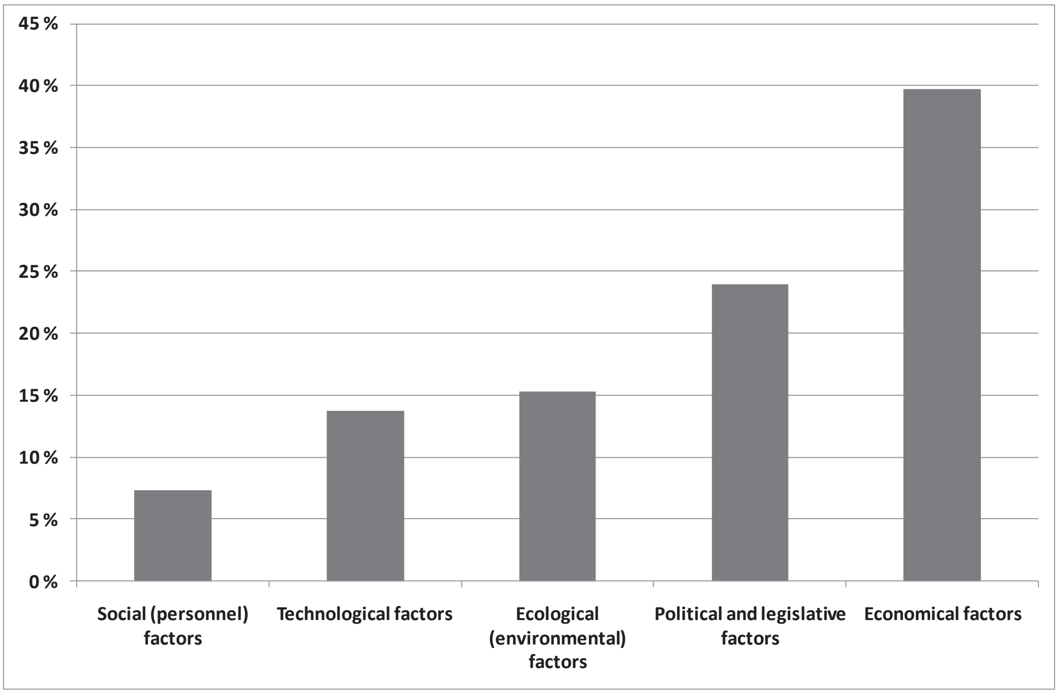


Multi-criteria decision making process have become increasingly popular in decision-making for sustainable energy because of the multi-dimensionality of the sustainability goal and the complexity of socio-economic and biophysical systems (Wang et al., 2009). It is crucial in energy field to have local acceptability for the projects. In the background of the acceptability there are the actors' determined strategic choices to focus on such production forms that can meet the needs of the society for decades. Large, renewable energy production investments will carry on in the future in order preventing the climate change. During 2005-2007 investments in new renewable capacity has nearly doubled measured in money (Worldwatch Institute, 2007).

In Europe the opening of the markets has led to a situation where more and more energy based companies are aspiring a new position in the industry or in the value chain. There has been seen an integration between different industry fields. Due to this new kind of actors have arisen alongside with traditional state/municipal owned corporations (Midttun, 2001). The importance of this matter is emphasized by European Union's an agreement on the goals of climate and energy policies. European Union has agreed to cut down GHG emissions by 20 per cent by 2020 from the level of 1990. At the same time European Union has committed to raise the share of renewable energy sources of final energy consumption from 8.5 per cent (in 2005) to 20 per cent by 2020. (Commission of the European Communities, 2007)

When investigating what factors have the largest impact on the life cycle profits of large scale energy production investment in Finland a clear connection was found: economical factors and political and legislative factors are the most important factors when deciding on energy production investments (Mäkipelto and Takala, 2009). Figure 3 shows the relative importance of the factors affecting on investment decisions.

Figure 3 Factors have the largest impact on the life cycle profits of large scale energy production investment in Finland and their importance relative to each other



According to figure 3 economical factors and political and legislative factors form over 64 per cent of the whole framework, in which the investment is based on. The factors in question are dependent on each other because political and legislative factors form wholeness which determines the sufficiency of economical factors. Typically the investments in energy field have to have a political and legislative framework so that the economical position can be secured with a relatively low profitability. There are even 20 years long repayment periods in energy industry (Du and Parsons, 2009).

1.1 The purpose of the research

The competitive strategies of today are often multi-focused. These strategies have not yet been tested enough empirically, especially in relation to investments in energy production and investment decision situations. The meaning of this research is to focus on the investments made in the energy industry and on understanding the factors affecting those investments. The main goal of the research was to modify the fast strategy model in energy industry which support to energy sector investors and equipment suppliers to development their enterprises. The sub goal was to analyze and understanding the energy industry decision making process and competitive priorities of the energy sector investments. The purpose in this research is to test the obtained results with the help of

The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry

case data. The suppliers can utilize these findings when constructing and modifying their strategies to be more sensitive.

Research's empirical data was collected by using mainly the researcher's observations and using earlier international researches (see e.g. Cai et al., 2009a; Bosetti et al., 2009; Xuebin, 2009; Kilanc and Or, 2008). Whit this research it is meant to go deeper on the earlier findings and expand the knowledge they bring.

In this research an innovative and theoretically justified solution has been created to answer a practical problem. The results have been tested with a weak market test. The method of the study consists of constructive and action oriented research approaches (Kasanen et al., 1993). The research combines existing theoretical knowledge and after that empirical results are compared to the theory. The external and internal validity of the dynamic decision making model developed in the research has been tested with a "weak" market test including interviews, brainstorming for the specialists in the industry.

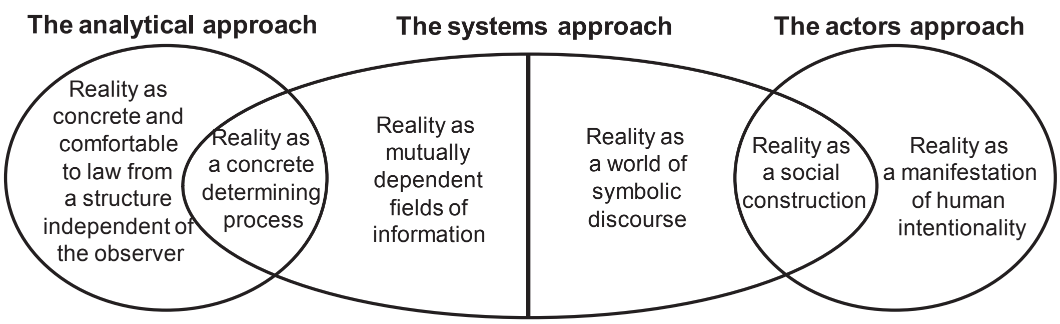
The energy industry is undergoing a changing process. Due to this process, investments in production processes have significantly reduced during the last decade. Uncertainty has grown with the capital intensiveness, long term energy production modes. Circumstances described above support the need for this research among the decision makers.

2 Research methodology and theoretical framework

The design of this research has been constructed so that it meets the epistemological and ontological world of the research. Research epistemology addresses how we come to know the reality by identifying the particular practices used to attain knowledge of it. Respectively ontology explains the relation of the research to the real world. Epistemological topic definitions are made in the part that concerns the goals of the research. Ontological part is being answered trough observations that are made based on the research results. Empirical observations of the research increase the ontological relation to the real world.

In this research, an innovative and theoretically justified solution is created for a practical problem. Research approaches that are used in economic sciences can be classified with different methods. Neilimo and Näsi (1980) have identified four different research approaches: nomothetical, decision oriented, action oriented and conceptual. Kasanen, Lukka and Siitonen added a constructive approach to the list above in their publication in 1993. Respectively Arbnor and Bjerke (1997) have identified three methodological approaches through the debates concerning research paradigms (Figure 4).

Figure 4 The three methodological approaches (Arbnor and Bjerke 1997)



This research has features from several different research approaches. According to Neilimo's and Näsi's (1980) definitions the research is closest to conceptual research approach. The goal of conceptual research is meant to develop concept systems that are based on empirical data and theories of subject in question. Concept systems have to process a specific activity or meaning and systems can be totally new or developed versions of known systems. (Olkkonen, 1993). Concept systems that are based on research results can be both declarative and recommending (Neilimo and Näsi, 1980). Respectively when reviewing the research according to Arbnor's and Bjerke's (1997) definitions it is closest to systems approach.

The methodology of this research is based on earlier literature in the field and case data concerning energy production. Literature on strategic leadership was especially made use of in the research. The model that was formed was tested using energy production data both temporally and with the help of sensitivity analysis. The research has been constructed around qualitative research approach. In a qualitative research the goal is to understand the researched phenomenon. This means determining the meaning or purpose of the phenomenon and constituting a deeper, holistic conception on the topic (Hirsjärvi and Huttunen, 1995).

The meaning of this research is to create a model that takes into account the development of investments in different periods of time. There are different factors in the background of the investments depending on whether it is a decision making situation, a situation at the end of investment's life cycle or a situation somewhere in between. In the strategic sense, the results of this research complement the article by Kilanc and Or (2008), in which a system dynamics model is developed to better understand and analyze the decentralized and competitive electricity market dynamics in the long run.

As the actor attaches itself to certain technical boundary conditions the future changes of the framework have to be taken into account especially carefully. The companies have to be able to adjust themselves particularly into political and legislative frameworks, so that the economical requirements can be guaranteed. Wittmann (2008) demonstrates how bounded rational decision models can be standardized and parameterized by socio-economic data. He focuses on private energy technology investment decisions and shows how different representative agents can be constructed using search rules, analysis tools and decision strategies.

Cai et al. (2009a) developed an interactive decision support system (UREM-IDSS) has been based on an inexact optimization model (UREM, University of Regina Energy Model) to aid decision makers in planning energy management systems. Bosetti et al. (2009) developed optimal energy investment and R&D strategies to stabilize atmospheric greenhouse gas concentrations. The model was used to find a balance between the climate, energy and economy. Cai et al. (2009b), on the other hand, have modeled the different factors affecting decisions in the renewable energy sector by giving an account of complex decision making processes. The operation field of energy industry can be described in several alternative ways. Bruckner et al. (2005) present two modelling strategies:

- high resolution modeling, is designed to capture the technical interactions and supervisory control practices and
- entity oriented modeling, builds on high resolution modeling by adding agents and markets in order to capture the commercial interactions which arise when multiple decision-makers are present.

These alternative descriptions are meant to illustrate how different factors in the industry connect to each other. Xuebin (2009) study presents a hybrid approach to solve the

The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry

combined economic-emission dispatch problem (CEED) between economic and environmental targets.

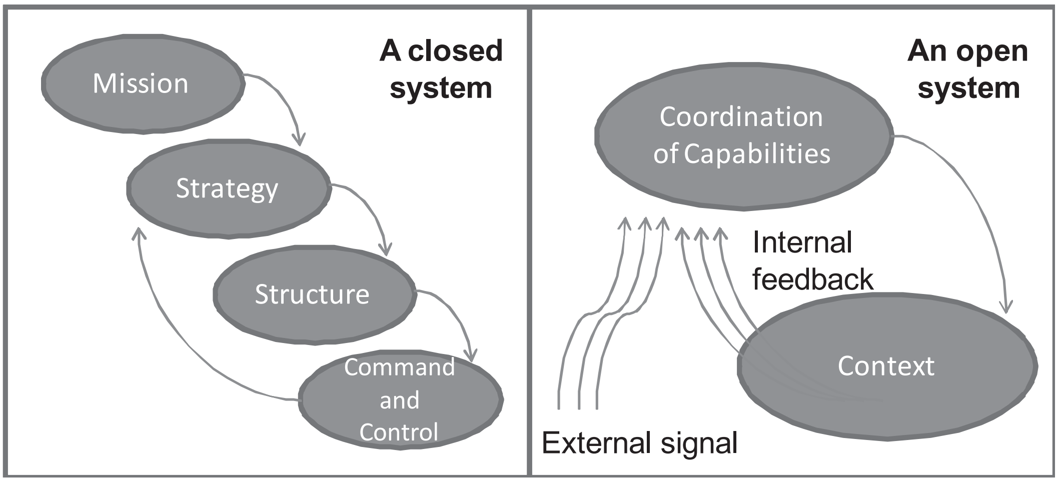
The research strategy has been divided into two stages. At the first stage the model is created and at the second stage the applicability of the model is tested using energy industry data from Scandinavia and the United States. The theoretical framework mainly consists of Peter Kunnas's (2009) saturation of an organisation's strategic issue management findings, Mikko Kosonen's and Yves Doz's Fast Strategies and Sense and Respond methods (see e.g. Haeckel, 1999; Snowden and Boone, 2007)

According to Mikko Kosonen's and Yves Doz's (2007; 2008a; 2008b), the companies should form their strategies to be more flexible and the strategic decisions should be agile. It should be possible to reform the companies' strategies continuously: weekly, daily or even hourly. The main components of strategic agility are strategic sensitivity, collective commitment and resource fluidity. According to Nieminen and Takala (2006) agility is company's ability to act and fight in the dynamic state of continuous changes.

The meaning of Strategic Sensitivity is both the sharpness of perception and the intensity of awareness and attention. Resource Fluidity means the internal capability to reconfigure business systems and redeploy resources rapidly. Collective Commitment means the ability of the top team to make bold decisions fast.

Respectively according to Stephan H. Haeckel (1999) companies' business can be led in two alternative ways: "make and sell" -principle or "sense and response" -principle. Make and sell principle forms an internal, closed system, in which signals from outside are not followed systematically. Sense and response principle utilizes internal feedback and external signals. Figure 5 describes the basic principles of both systems.

Figure 5 Two alternative strategic ways to lead a company



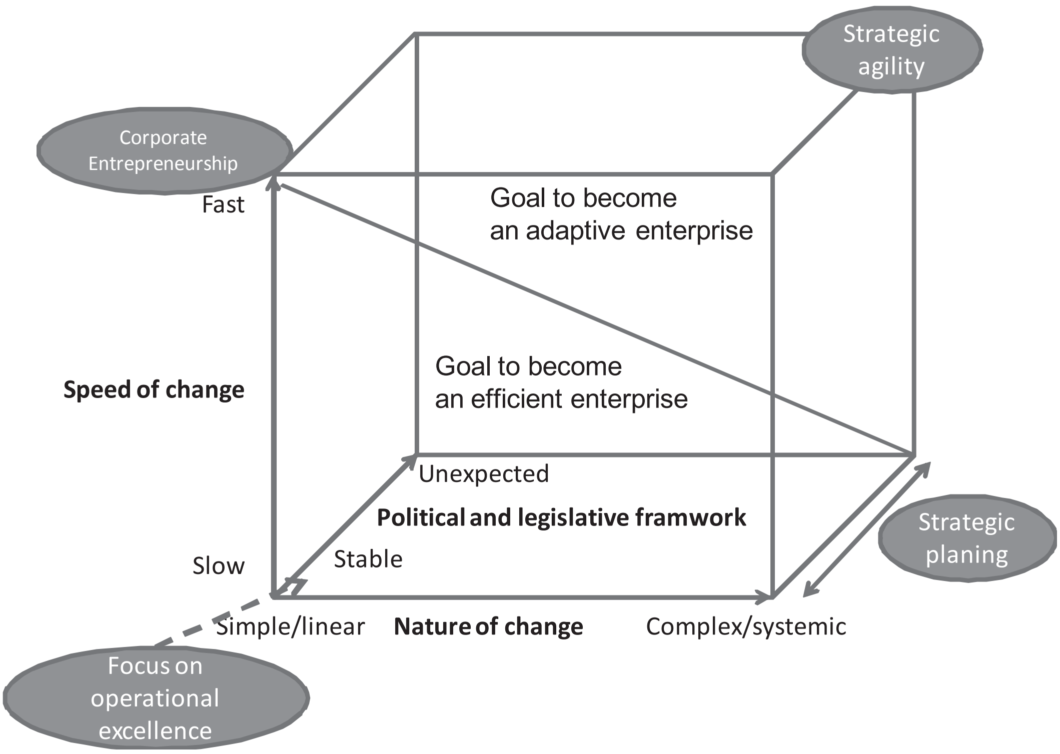
Source: Haeckel (1999)

According to sense and response -principle companies look for influences from outside the company and act on them. These two principles can also be described as open and closed system. The hierarchy of the closed system also separates these two systems.

Accorging to Doz and Kosonen (2008a) a fourfold table has been created. The meaning of the table is to specify the relation between strategic agility and corporate entrepreneurship, strategic planning and operational excellence. Respectively Heackel (1999) separated two different goals: goal to become an adaptive enterprise and goal to become efficient enterprise.

Strategic leadership can be interpreted as the whole activity of the company or as a strategic leading of certain part of the whole. Figure 6 shows how strategic agility is placed with speed of change, nature of change and political and legislative framework.

Figure 6 Strategic agility and response in relation to changing factors in energy industry (adapted Kosonen and Doz (2008a) and Heackel (1999))



Examining the same thing from sense and response point of view it can be seen that Figure 6 points out how companies' goals are placed in relation to operating area. The framework shows that when the operating challenges grow the operation model should be guided to be more strategically agility.

According to Hamel, Doz and Prahalad (2002) common factors, which affect on strategic sensitivity and noticing external signals, arise when viewing cooperation between different companies and competitors. These factors are:

- collaboration is competition in a different form,
- harmony is not the most important measure of success,
- cooperation has limits. Companies must defend against competitive compromise and
- leaning from partners is paramount.

Respectively C.K. Prahalad and M.S. Krishnan (2008) think that companies have to include clients individually in the process of creating business and that companies have to be able to continuously gather up the best resources and knowledge in the world. Kunnas (2009) has examined how companies can analyze their strategic core questions.

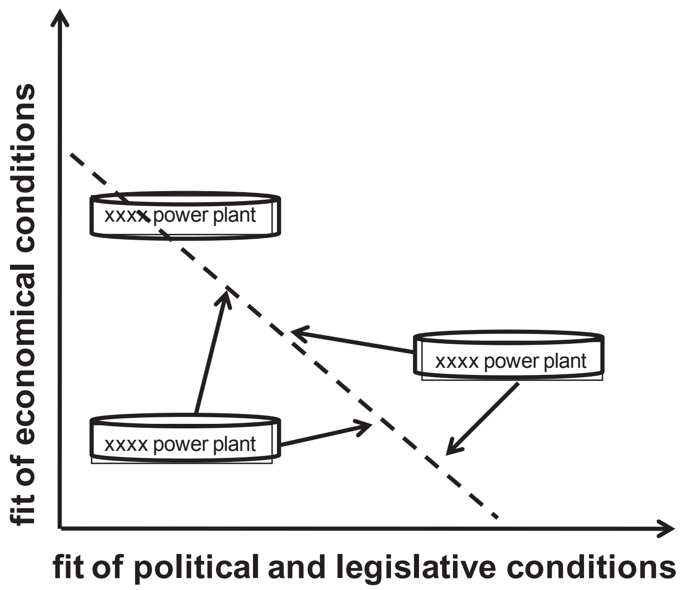
Cooperating and learning by that is part of the communication process between actors, it is also part of viewing strategic options, searching new competitive advantages and adapting to the political and legislative framework.

The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry

3 Results and analysis

A model that combines existing strategic models has been created as a result of this research. The model also completes the existing knowledge by taking into account the empirical facts from energy industry's experts. As can be seen in Figure 3 the most important factors are economical and political and legislative conditions when making investment decisions in energy industry. These factors are attached to each other. The more unsure the political and legislative sustainability is the larger is the economical yield expectation and vice versa. The factors are not necessarily directly proportional in every occasion and within every production mode. Figure 7 illustrates the situation.

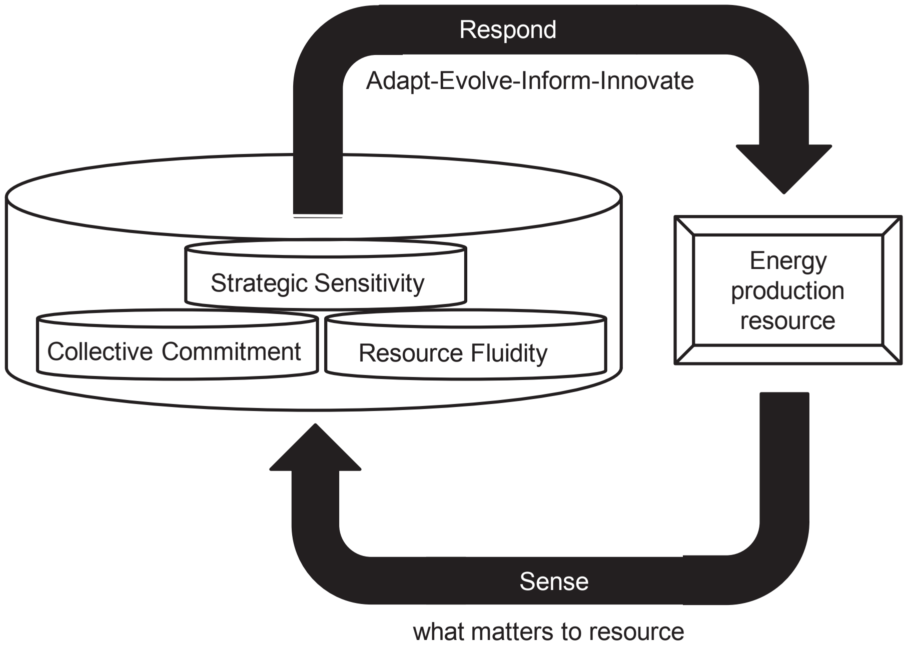
Figure 7 The paths leading to energy power plant investment decision



Depending on the energy production mode there are different profit expectations in different political and legislative frameworks. Perceiving the framework in question requires strategic leading, continuous observing of business environment and guiding the business operations to the desired course. Strategic leading is meant to find the beneficial timeframes when the desired conditions for investments exist. A beneficial investment situation is a wholeness which requires simultaneous support from every interest group around the project. This is affected by the financiers' positions, technological possibilities, political atmosphere, availability of workforce, demand for the product and its market price etc. (see e.g. Wittmann, 2008).

Combining the results of this research with the existing theoretical framework a model is created. The meaning of this model is to map the state of the surrounding framework and conditions as Figure 9 shows. Based on Kunnas (2009); Kosononen & Doz (2008a); Heackel (1999); Hamel, Doz and Prahalad (2002); C.K. Prahalad and M.S. Krishnan (2008) earlier researches a process chart has been created. The functionality of this process chart has been tested by interviewing the experts in the energy industry. In Figure 8 strategic agility, sense and response -principle are combined so that unique competitive advantage is created by utilizing the added value gained by strategic alliances.

Figure 8 Dynamic strategy model for energy sector



Utilizing the best talents is extremely important in companies' strategies. This is represented on the left side of Figure 8 as its own unity. Companies' business operations have to be able to adapt on the influences coming from outside. By utilizing these influences and possibilities companies can achieve competitive advantage relative to other actors in the industry if they succeed in strategic leadership.

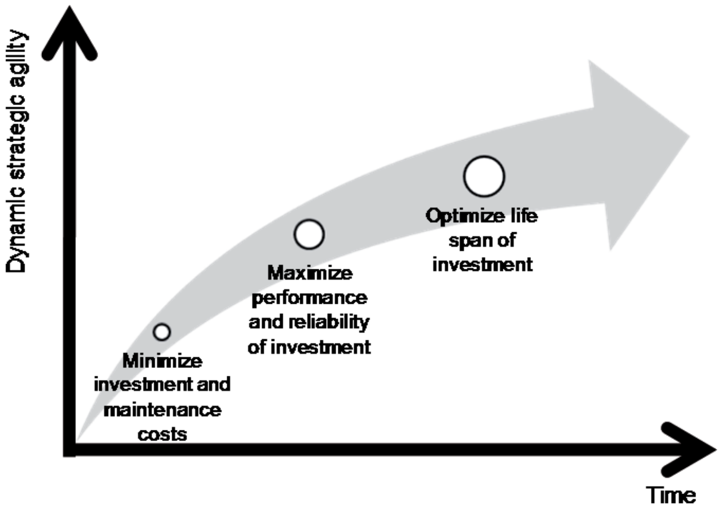
When reviewing especially the content of energy production recourses it can be seen that according to the findings of the earlier research (Mäkipelto, 2009) three connected factors emerge in the investment decision making process. These factors are:

- minimize investment and maintenance costs,
- maximize performance and reliability of investment and
- optimize life span of investment.

These factors can be put into a time span which tells the size of influencing possibilities of strategic agility in relation to time. In Figure 9 it is presupposed that origin is in time n-1 and first circle is at the moment of the investment decision n.

The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry

Figure 9 Relation between dynamic strategic agility, time and set goals



Through dynamic strategic agility, as Figure 9 shows, the main goals that investors hold important when investing in large scale, capital intensive energy production plants. Importance of dynamic strategic agility grows when going further in the timeline because the investment situation has changed into maintenance of the production plant and actions required by the outside framework.

Efficiency advantages throughout the whole life span of the investment can be achieved by acting strategically consistent. Operating in the energy industry differs from many other industries because of its capital intensiveness and political influences on the business. Investment decision making processes are characterised by long repayment periods which differ from many other industries fields.

4 Evaluation of results

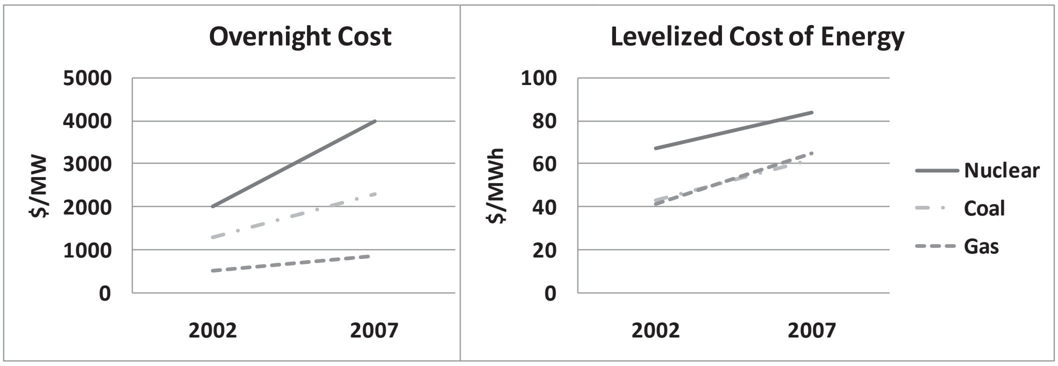
The research results have been tested based on international data. Yangbo Du and John E. Parsons (2009) have examined the energy productions costs of nuclear, coal and gas power in 2002 and 2007. Respectively Tarjanne and Kivistö (2008) have done comparisons in electricity production prices in Nordic context in 2008. Streimikiene et al. (2008) have researched external costs of electricity generation in Baltic States. Lee et al. (2009) have studied investment-related decision-making in the wind power industry from a strategic perspective. The study sheds light on the critical success factors of wind power investments in China, analysing the related benefits, opportunities, costs and risks. Investment decision point of view Couture and Gagnon (2010) have researched the advantages and disadvantages of different energy production support systems (feed-in tariffs).

This research examines the direct costs of energy production. In Tarjanne's and Kivistö's research a profitability comparison is made between different production modes of electricity mainly in Finland. Profitability comparison is made with an annuity method with 5 % real interest and price level of January 2008. According to calculations with an 8 000 peak load hours production costs for nuclear electricity would be 35,0 €/MWh, gas electricity 59,2 €/MWh and coal electricity 64,4 €/MWh, when the price for carbon dioxide emission right is 23 €/tCO_2. Without emission right the price for gas electricity is 51,2/MWh and coal electricity 45,7 €/MWh while the price for core electricity stays the same. Respectively according to Yangbo Du's and John E. Parsons' (2009) international research the production cost for core electricity is 84 $/MWh (about 59,2 €/MWh), for coal 62 $/MWh (about 43,7 €/MWh) without emission trading effects and for gas 65 $/ MWh (about 45,8 €) also without the effects of emission trading. These researches are not comparable with each other because the frameworks of energy production are largely affected by political and legislation factors (see Figure 3). This has a direct impact on competitive advantage of different energy production modes in different countries.

In Appendix 1 Tarjanne's and Kivistö's (2008) research on electricity production cost in different production modes without emission trading effects has been reviewed. In the figure x-axis illustrates the percentage affect on y-axis's electricity production costs with different variables. Depending on the production mode the importance of research results in calculating the profitability varies. According to the figures in Appendix 1 the three research statements on minimizing investment costs, optimizing O&M costs and optimizing investment life cycle have an effect on energy production costs and therefore on the profits of the investment. This proves that optimizing the factors that are examined in this research is worthwhile.

Respectively when reviewing the research results in view of Yangbo Du's and John E. Parsons's (2009) international investigation the importance of the results can be examined in relation to time. According to the research production costs of nuclear power, coal and gas based electricity energy has risen from year 2003 to year 2007. This means that the importance of the management model that is based on research results has risen as well from 2003 to 2007. However the influence of inflation has to be taken into account. Figure 10 illustrates this in the context of nuclear power, coal and gas based electricity.

Figure 10 The development of life cycle and investment costs of electrical energy produced by nuclear, coal and gas



It can be seen in the Figure 10 that fast strategy and dynamic decision making process have increasingly important roles in energy industry in the future.

There is an ongoing debate on how to estimate reliability and validity in qualitative research (see e.g. Shenton, 2004). The validity of a research refers to the extent to which the research measures the intended phenomenon. In qualitative empirical research, tests of validity are most often used to examine construct validity, internal validity and external validity (Yin, 2009). The construct validity of the research depends on how well the selected measures reflect the phenomenon under investigation. The construct validity of this research was strengthened by comparing actual data from different energy production forms and thus transforming partly abstract research findings into a

The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry

measurable form. The internal and external validity of the research was strengthened by making use of assessments made by industry experts and colleagues on the extent to which energy production costs and their logic reflect the most essential part of decision making. Internal validity measures the logic between observations and inferences. External validity deals with the generalizability of the research findings. On the whole, the validity of this research could be further reinforced by testing and explaining the results with the help of alternative methods, such as interviews and international comparisons.

The reliability of a research concerns the degree to which the studied subject can be tested, how reliable and durable the method used is and how consistent the results are. In this research, the reliability was strengthened by testing the main findings and the model created within a Nordic and a US context. The material used in the research was up-to-date and comprehensive. The results were consistent. They were tested temporally and with the help of sensitivity analysis. It would, however, be possible to further strengthen the reliability of the research by testing the results in a more detailed manner and measuring the phenomenon in question using several different variables.

The research results can be widened, deepened and tested by separate ways. In the following researches the international interface should be expanded and tested by alternative ways. The results can also be deepened by testing the model in some other industry such as telecommunication business.

5 Conclusions, limitations and further research

The main goal of the research was to link together different strategic models and then modify the special agility strategy model for energy industry. The sub goal was to analyze decision making process in the energy industry and competitive priorities of the investment in energy sector. The energy industry is exceptional because of not only the limitations set by ownership and cost structure, but also limitations set by the official supervision and special technical features.

In the research, factors were found that have an effect on investment decisions in the energy industry, and they were combined with existing leadership theories. The results were tested using energy production cost data from Scandinavia and the United States. The usability of the results is limited by the fact that the research material is focused on Scandinavia and the US and by restrictions related to the validity and reliability of the results. The results are up-to-date within the context of the research. As a subject for further research, the usability of the results could be improved by testing the findings with different case material. Such case material could consists for example of interviews with industry decision makers conducted in different geographical areas and focusing on certain energy production forms.

The research findings give the investors a possibility to reform their strategies to be more sensitiveness way and the same time make own fast & dynamic decision model. The results reveal the most important strategic factors and their effects on the production costs of the case energy production forms within the chosen framework. The theoretical part of the research consisted of the different strategic methods. This work results help to enterprise leader's understand the energy business and also give possibilities development their companies.

The process will help the investors to understand energy sectors' global context and new modified strategy model in energy sector. The results showed that the model of the fast strategy and dynamic decisions in energy industry are created and test in mainly the local contexts.

The results of this research are a contribution to science because they fulfill the goal that was set for this research and its starting point lies on previous literature on the matter. This work links also to the existing scientific research. In the future, it is obvious that certain changes are taking place in the industry and, therefore, the dynamic multi-criteria decision making process will help decision makers to modify their strategies to be more agility.

References

Arbnor, I. and Bjerke, B. (1997) ‘Methodology for Creating Business Knowledge’, Sage Publications, London.

Bergmann, A., Hanley, N. and Wright, R. (2006) ‘Valuing the attributes of renewable energy investments’, Energy Policy, Vol. 34, pp.1004-1014.

Bosetti, V., Carraro, C., Massetti, E., Sgobbi, A. and Tavoni, M. (2009) ‘Optimal energy investment and R&D strategies to stabilize atmospheric greenhouse gas concentrations’, Resource and Energy Economics, Vol. 31, pp.123-137.

Bruckner, T., Morrison, R. and Wittmann, T. (2005) ‘Public policy modeling of distributed energy technologies: strategies, attributes, and challenges’, Ecological Economics, Vol. 54, pp.328-345.

Cai, Y., Huang, G., Lin, Q., Nie X. and Tan, Q. (2009a) ‘An optimization-model-based interactive decision support system for regional energy management systems planning under uncertainty’, Expert Systems with Applications, Vol. 36, pp.3470-3482.

Cai, Y., Huang, G., Lin, Q., Nie X. and Tan, Q. (2009b) ‘Community-scale renewable energy systems planning under uncertainty - An interval chance-constrained programming approach’, Renewable and Sustainable Energy Reviews, Vol. 13, pp.721-735.

Commission of the European Communities. (2007) ‘Communication from the Commission to the European Council and the European Parliament: An Energy policy for Europe’, Brussels, Commission of the European Communities.

Doz, Y. and Kosonen, M. (2007) ‘The New Deal at the Top’, Harvard Business Review, Vol. 6, pp.98-104.

Doz, Y. and Kosonen, M. (2008a) ‘Fast Strategy: How Strategic Agility Will Help You Stay Ahead of the Game’, Wharton School Publishing, Great Britain.

Doz, Y. and Kosonen, M. (2008b) ‘How agile is your strategy process?’, Strategy Magazine, Vol. 15, pp.6-10.

Couture, T. and Gagnon, Y. (2010) ‘An analysis of feed-in tariff remuneration models: implications for renewable energy investment’, Energy Policy, Vol. 38, pp.955-965.

Du, Y. and Parsons, J. (2009) ‘Update on the cost of nuclear power’, Nuclear fule cycle technology and policy program. Massachusetts Institute of Technology, Cambridge.

The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry

Haeckel, S. (1999) 'Adaptive enterprise, creating and leading sense-and-respond organization', Harvard business school press. Boston, Massachusetts.

Hamel, G., Doz, Y. and Prahalad, C.K. (2002) 'Collaborate with your competitors-and win', Harvard Business Review on Strategy Alliances. Harvard Business School Publishing Corporation. Boston, United States of America.

Hirsjärvi, S. and Huttunen, J. (1995) 'Johdatus kasvatustieteeseen', (4th edition). Porvoo, Helsinki, Juva: WSOY (in Finnish).

Intergovernmental Panel on Climate Change. (2007) 'Climate Change 2007: Synthesis Report', an Assessment of the Intergovernmental Panel on Climate Change.

Kasanen, E., Lukka, K., and Siitonen, A. (1993) 'The Constructive Approach in Management Accounting Research', Journal of Management Accounting Research, Vol. 5, pp.241-264.

Kilanc, G. and Or, I. (2008) 'A decision support tool for the analysis of pricing, investment and regulatory processes in a decentralized electricity market', Energy Policy, Vol. 36, pp.3036-3044.

Kunnas, P. (2009) 'Systematic management of emerging strategic issues: organizational attention allocation and strategic issue management system performance', Espoo: Department of Industrial Engineering and Management, Doctoral dissertation, Helsinki University of Technology.

Lee, A., Chen, H. and Kang, H. (2009) 'Multi-criteria decision making on strategic selection of wind farms', Renewable Energy Vol.34, pp.120-126.

Midttun, A. (2001) 'European Energy Industry Business Strategies', Elsevier, Amsterdam, San Diego, Oxford, London.

Moran, D. and Sherrington, C. (2007) 'An economic assessment of wind farm power generation in Scotland including externalities', Power Policy Vol. 35, pp.2811-2825.

Mäkipelto, T. (2009) 'Competitive priorities of investment strategy: case wind power', International Journal of Sustainable Economy, Vol. 1, pp.388-402.

Mäkipelto, T. and Takala, J. (2009) 'The model based on the analytic hierarchy process for dynamic decision making in the energy industry: a case analysis of investment energy production in Finland', International Journal of Nuclear Governance, Economy and Ecology, Vol. 2, pp.281-295.

Neilimo, K. and Näsi, J. (1980) 'Nomoteettinen tutkimusote ja suomalainen yrityksen taloustiede, tutkimus positivismin soveltamisessa'. Tampereen yliopisto, yrityksen taloustieteen ja yksityisoikeuden laitoksen julkaisuja, sarja A 2: 12 (in Finnish), Tampere.

Nieminen, P. and Takala, J. (2006) ‘Achieving better on-time-delivery performance with the help of internal dependencies in the production’, International Journal of Management and Enterprise Development, Vol. 3, pp.181-190.

Olkkonen, T. (1993) ‘Johdatus teollisuustalouden tutkimustyöhön’, Teknillinen korkeakoulu, teollisuustalous ja työpsykologia. Report No 152 (in Finnish), Otaniemi, Espoo.

Prahalad, C.K. and Krishnan, M.S. (2008) ‘The new age of innovation. Driving co-created value through global networks’, McGraw Hill. New York.

Shenton, A. K. (2004) ‘Strategies for ensuring trustworthiness in qualitative research projects’, Education for Information Vol. 22, pp.63-75.

Snowden, D. and Boone, M. (2007) ‘A leader’s framework for decision making’, Harvard business review, pp.61-69.

Streimikiene, D., Roos, I. and Rekis, J. (2008) ‘External cost of electricity generation in Baltic States’, Renewable and Sustainable Energy Reviews. Vol. 13, pp.863-870.

Tarjanne, R. and Kivistö, A. (2008) ‘Comparison of electricity generation costs’, Research Report B-175 (in Finnish), Lappeenranta University of technology, Faculty of Technology, Department of Energy and Environmental Technology, Lappeenranta.

Wang, J-J., Jing, Y-Y., Zhang, C-F. and Zhao, J-H. (2009) ‘Review on multi-criteria decision analysis aid in sustainable energy decision-making’, Renewable and Sustainable Energy Reviews, Vol. 13, pp.2263-2278.

Wittmann, T. (2008) ‘Agent-Based Models of Energy Investment Decisions’, Doctoral dissertation, Technical University of Berlin, Sustainability and Innovations, Physica-Verlag Heidelberg.

World Health Organization. (2003) ‘Climate change and human health -risks and responses report’, World Health Organization, Switzerland.

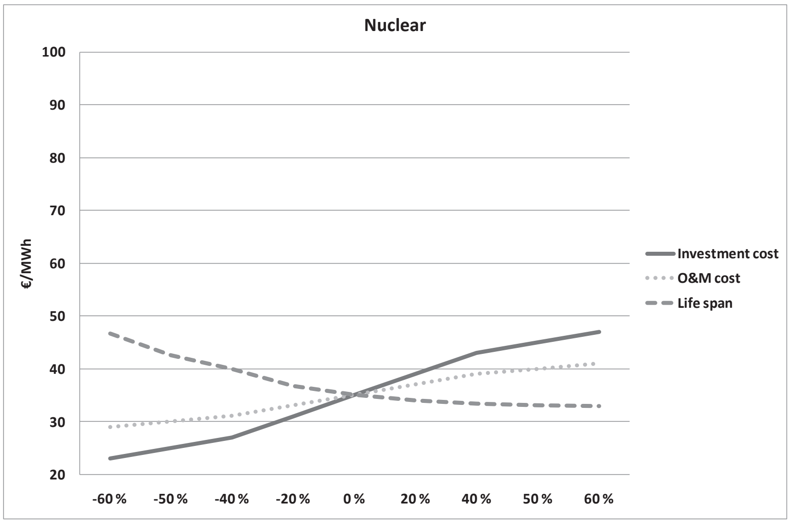
Worldwatch Institute. (2007) ‘Renewables 2007: Global Status Report’, Renewable Energy Policy Network for the 21st Century, Washington.

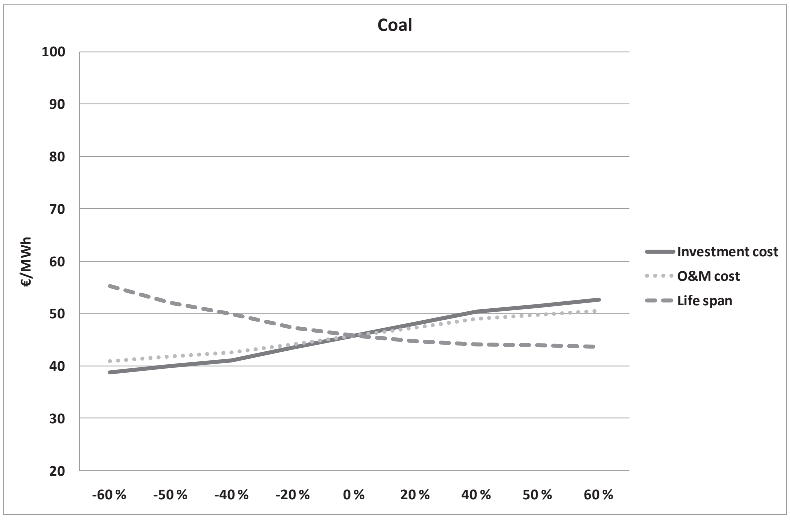
Xuebin, L. (2009) ‘Study of multi-objective optimization and multi-attribute decision-making for economic and environmental power dispatch’, Electric Power Systems Research, Vol. 79, pp.789-795.

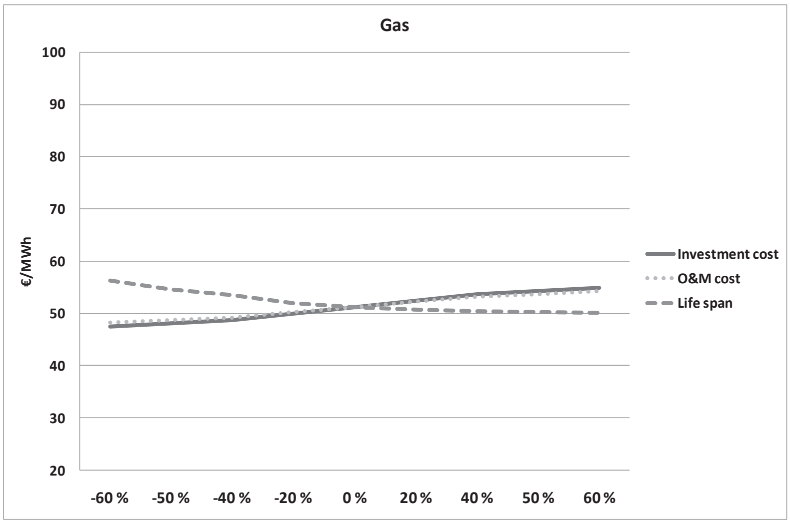
Yin, R. K. (2009) ‘Case Study Research: Design and Methods’, 4th edition, Sage Publications Inc., California.

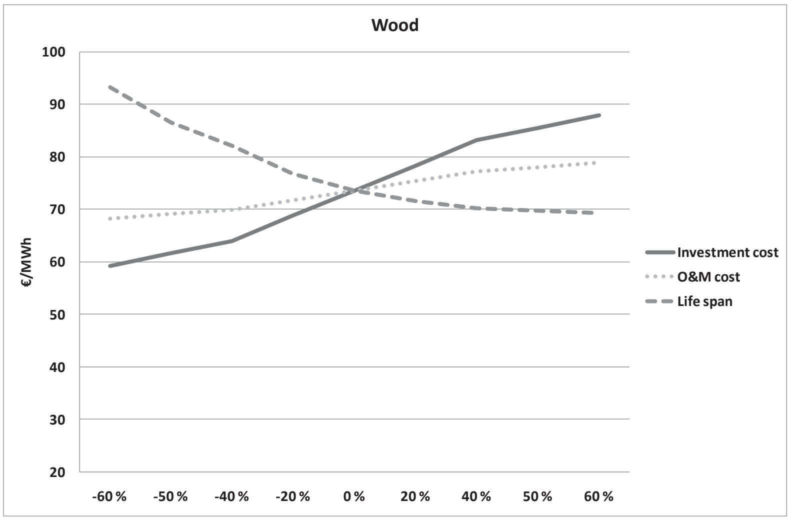
The Model Based on the Analytic Hierarchy Process for Dynamic Decision Making in the Energy Industry

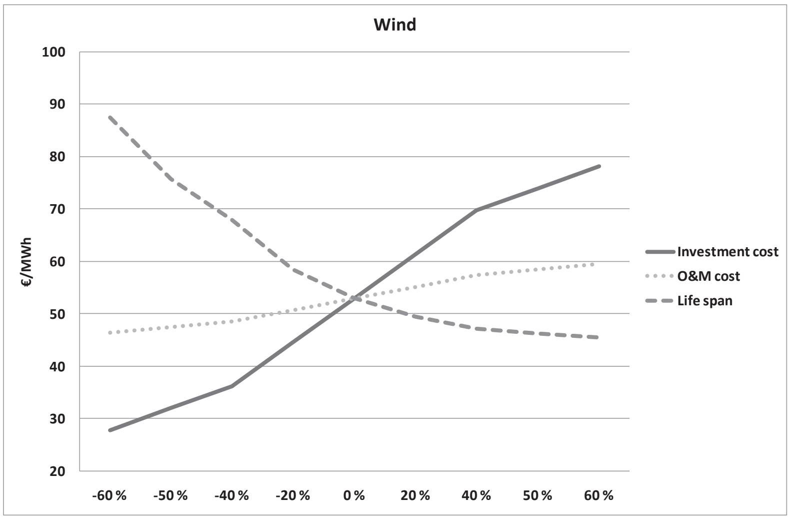
APPENDIX 1

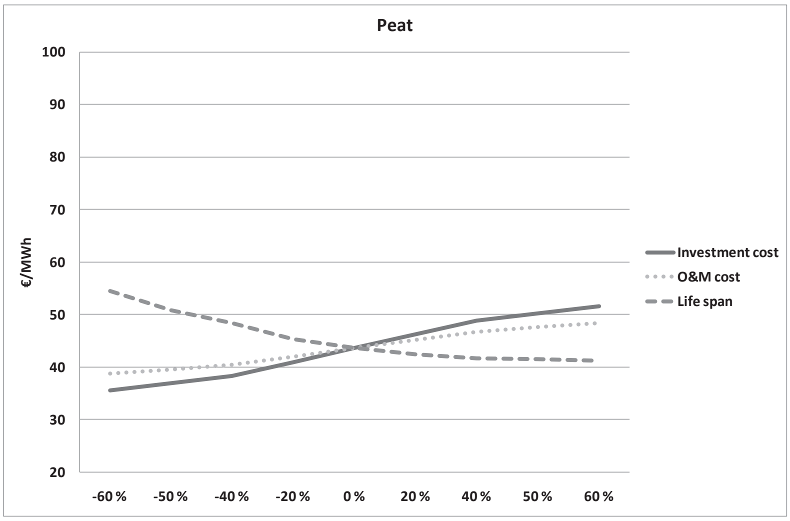







Wood
100
90
80
70
60
50
40
30
20
€/MWh
-60 %
-50 %
-40 %
-20 %
0 %
20 %
40 %
50 %
60 %
Investment cost
O&M cost
Life span


Wind
100
90
80
70
60
50
40
30
20
€/MWh
-60 %
-50 %
-40 %
-20 %
0 %
20 %
40 %
50 %
60 %
Investment cost
O&M cost
Life span


Peat
100
90
80
70
60
50
40
30
20
€/MWh
-60 %
-50 %
-40 %
-20 %
0 %
20 %
40 %
50 %
60 %
Investment cost
O&M cost
Life span

Int. J. Innovation and Learning, Vol. X, No. Y, xxxx 1

The framework factors affecting the acceptability of wind power

Tomi Mäkipelto

Department of Production, Faculty of Technology,
University of Vaasa
P.O. Box 700, Vaasa FI-65101, Finland
E-mail: tomi.makipelto@student.uwasa.fi

Abstract: The goal of this research is to evaluate and analyse the factors that have an effect on the acceptability of wind power investment in decisions making situation. The used research methodologies were an action analytical and a constructive case research. Empirical data was collected by using formal questionnaires, observations of the researcher and informal discussions.

The results of this research help utility investors and country/municipality level decision makers to learn and understand how the operational environment affects on wind power investments that have an effect on the growth of renewable energy forms.

Keywords: wind power; strategic management; innovation; learning; conditions of investment.

Reference to this paper should be made as follows: Mäkipelto, T. (xxxx) 'The framework factors affecting the acceptability of wind power', *Int. J. Innovation and Learning*, Vol. X, No. Y, pp.000–000.

Biographical notes: Tomi Mäkipelto MSc (Tech.), Post Graduate student in Faculty of Technology at the University of Vaasa in Finland. He received his Master of Science in Technology at the Tampere University of Technology in 2005. His field of interest is the investment decision process in the energy industry. His work experience backgrounds: Managing Director in Rajakiiri Oy, EPV Tuulivoima Oy and Suomen Merituuli Oy (investment companies, focus investment to windfarms in Finland) 2007, Vice President, Corporate Strategy and Development in EPV Energia Oy 2008, Development Manager in Etelä-Pohjanmaan Voima Oy 2006–2008, Expert, Business Economics in Etelä-Pohjanmaan Voima Oy 2006–2005.

1 Introduction

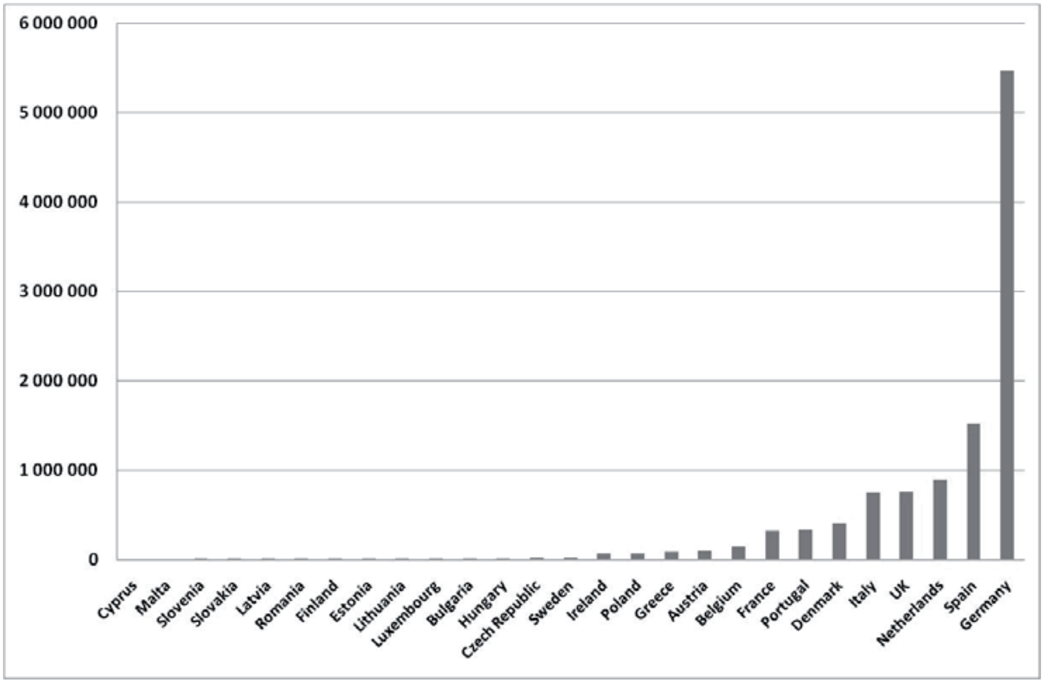
The changes in energy politics have been rapid during the last few decades relative to the long pay back periods in the industry. The changes have been in the framework of the industry and in the single technical-economical guidelines. On one hand energy industry is local because of the restricted mobility of the final product (electricity). On other hand the industry is global because of the global fuel (etc. coal, nuclear and gas) and equipment market. This means that the guidelines made in EU affect differently on competitive advantage of each member country in energy production if the countries have the possibility to carry out the political goals. Parallel impact can be seen between Europe, Russia and China.

The changes in energy politics are causing modification or total renewals in the existing energy production plants. At the same time the need to build new plants is growing because of the rise in energy consumption (International Energy Agency, 2008).

In addition to global politics, energy production can be examined trough feelings of citizens. Politically accepted energy production form is not automatically accepted by the local people who live in the target area of the energy production project. In this research it is examined how people regard wind power in Finland, where there were only 119 wind power plants by the end of 2008 (Holttinen and Stenberg, 2009).

The amount of wind power construction can be reviewed with several specific indicators. These indicators can for example be the total built wind power efficiency and wind power efficiency per km^2. The relative amount of built wind power in relation to population and surface area can be reviewed with intensity factor. Intensity factor means the built wind power efficiency multiplied by the popular density per km^2 in the country in question. The intensity factor in Europe has been shown in Figure 1.

Figure 1 Population per square kilometre (km^2) multiple installed wind power capacity (MW) per each EU 27 country by the end of 2008



Source: Eurostat (2009) and EWEA (2009)

According to Figure 1, there are intensity factor about 2,200 in Finland. At the same time that factor is 888,000 in Netherlands, 1,520,000 in Spain and 5,472,000 in Germany. This means that the people experience different amounts of wind power in their everyday life depending on where in Europe they live. Wolsink (2007) has researched how the wind power unit and also wind power park acceptability changes in different project phases.

Typically preparation for energy production investments can take several years, even a decade. Respectively the building stage takes typically from a year to five years and the production stage from several years to decades (cf. wind, nuclear and hydro power). This means that already during the planning process the framework can be changing. This creates a considerable uncertainty on how the operating conditions for energy power plants evolve over the years and decades.

1.1 The goal of the research

The goal of this research is to evaluate and analyse the factors that have an effect on the acceptability of wind power investment in decisions making situation in utility investors' and county/municipality level decision makers' point of view. This research is restricted to apply only to wind power acceptability, because technological options are similar worldwide and economical profitability depends on each country's legislative framework. In this research concept acceptability is determined as a one of the factors that are needed for the execution of the project. Respectively feasibility is a parent definition, which is required for the project to be executed as a whole. Evaluation is made by examining the acceptance of wind power projects in countries where the level of built wind power per surface area is relatively low in EU level but still produces remarkable amounts of wind power related technological products (workplace affect).

Niiniluoto (1996) has used example the following formula with six Es in assessing (technology assessment) information and communication technology (ICT) and the qualities of technologies:

$$\begin{aligned} Techno\log y\ Assesment = & (Efficiency \times Economy \times Ergonomics \times Eco\log y \times Esthetics \times Ethics) \\ & + Social\ \ consequences \end{aligned}$$

The purpose of the formula is to make clear what factors have to be taken into account when launching ICT products. Because of the nature of the formula, any of the Es cannot be left without consideration so that the qualities of the technology can meet the needs of the consumer.

From an ecological point of view there are several models that can be used in reviewing the consequences of the project. These models are for example the IPAT (Holdren and Ehrlich, 1974) and ImPACT-model (Waggoner and Ausubel, 2002). York et al. (2003) have researched the detailed differences between these two models.

By utilising these existing models, a specific and innovation formula can be constructed to wind power industry. With the help of the model the investment decision conditions of wind power construction can be assessed. The model consists of three factors: A = acceptance, E =economy and T = technology. In this research the model is called TEA-model.

When considering energy production projects innovation TEA-model points out on what technological (T) choices the investor can affect on. Economics (E) of the project are influenced by the price of energy, taxation and other economical and political guidelines. The acceptance (A) of the project is influenced by several outside factors, which are considered in this research.

In wind power industry TEA-model can also be reviewed as an equation:

$$F(x) = T(x) * E(x) * A(x)$$
$$0 \leq T(x) \leq 1$$
$$0 \leq E(x) \leq 1$$
$$0 \leq A(x) \leq 1$$

If *F(x)* > 0, a lot of wind power construction is taking place in the area in question. If *F(x)* = 0, wind power construction is not possible in the area.

The equation means that building wind power is possible if it is technically possible, it meets economical conditions and the project has general acceptance. Some of the factors can be left out of the equation on the grounds of obligations and entitlements based on local legislative decisions.

It can also be assumed that the same wind power technology is available everywhere in the area in question. This means that it does not explain the differences between countries in building wind power (see Figure 1). Therefore, TEA-model can be simplified in to $F(x) \sim E(x) * A(x)$.

Uncertain operating environment affects on the economical risk margins of the project and thereby required profit expectations. Anthoff and Tol (2008) have researched the complexity of the planning by examining expectations for return on investment in different locations.

The large amount of technological solutions is part of the uncertainty of operating environment. When examining the development of sustainable energy production Lund (2007) has found three starting points: savings in energy consumption will be remarkable when examining consumption (Blok, 2005; Lund, 1999); energy production should be more and more efficient (Lior, 1997, 2002); fossil fuels will be replaced by renewable energy fuels (Afgan and Carvalho, 2002, 2004). EU’s climate and energy political decisions also support these three points (COM, 2006, 2007).

Wind power investments are typical capital intensive investments. The fixed costs are remarkable compared to variable costs. The length of absolute lifecycle of investments has a great impact on the profitability.

This also has a great affect on assessing the risk that has an impact on the whole profitability of the project. The framework of future is hard to asses and therefore, the influence it has on energy investments future profits and costs structure.

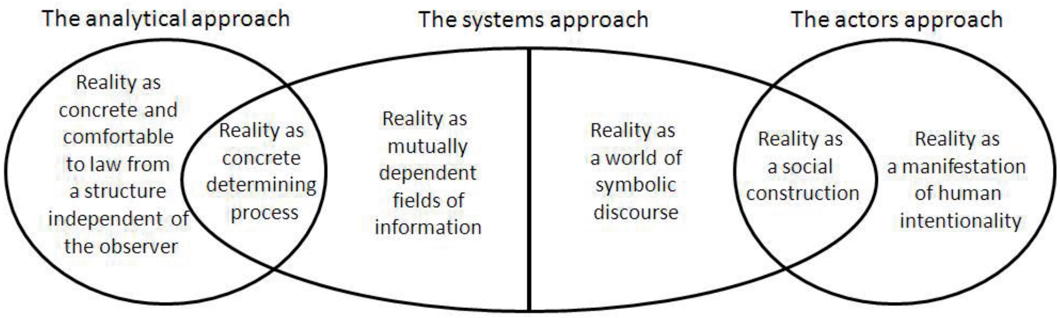
With the technological choices of the energy production method it is possible to impact on the cost efficiency and therefore, profitability. The relative efficiency of energy production in relation to investments in the long run tells about the efficiency of the production method.

2 Research design, strategy and theoretical framework

The design of this research has been constructed so that it meets the epistemological and ontological world of the research. Research epistemology addresses how we come to know the reality by identifying the particular practices. Respectively ontology explains the relation of the research to the real world. Epistemological topic definitions are made in the part that concerns the goals of the research. Ontological part is being answered trough observations that are made based on the research results. Empirical observations of the research increase the ontological relation to the real world.

In this research, an innovative and theoretically justified solution is created for a practical problem. Research approaches that are used in economic sciences can be classified with different methods. Neilimo and Näsi (1980) have identified four different research approaches: nomothetical, decision oriented, action oriented and conceptual. Kasanen et al. (1993) added a constructive approach to the list above in their publication in 1993. Respectively Arbnor and Bjerke (1997) have identified three methodological approaches through the debates concerning research paradigms (Figure 2).

Figure 2 The three methodological approaches



Source: Arbnor and Bjerke (1997)

This research has features from several different research approaches. According to Neilimo's and Näsi's (1980) definitions the research is closest to action oriented research approach. According to Neilimo and Näsi (1980) characteristics of action research are the following:

- teleological explaining method
- action science
- the goal is to understand
- empirical part usually consists of only few units
- there is no established methodological rules
- results are often concept systems.

Respectively when reviewing the research with Arbnor's and Bjerke's (1997) definitions the approach is closest to systems approach.

This research is constructed around qualitative research approach. In a qualitative research the goal is to understand the researched phenomenon. This means determining the meaning or purpose of the phenomenon and constituting a deeper conception on the topic (Hirsjärvi and Huttunen, 1995).

In this research, empirical data was collected by using formal questionnaires and by using the researcher's observations including informal discussions. In this research, an innovative and theoretically justified solution has been created to answer a practical problem. The results have been tested with a weak market test. The approach is constructive (Kasanen et al., 1993).

The research method is an action research in which the research is combined with existing theoretical knowledge and after that empirical results are compared with existing theory. The external validity of the model has been tested with a 'weak' market test including a questionnaire for citizens. The internal validity of the model was tested by raising the amount of applicants.

3 Building the research method

This research focuses on analysing the acceptance of wind power and strategic decision making in changing operation environment. This is new because researched focusing country where wind power is quite new and viewpoint is different than researched which focusing general public acceptance or how to the acceptance develops during the project (Eltham et al., 2008; Wolsink, 2007).

The research method is based on large survey conducted by random sample in which the respondents were asked about their background, experiences and their ideas about future of energy industry in general and especially about wind power.

Research data was collected by a separate questionnaire. The questionnaire was implemented in native tongue of the respondents (Finnish and Swedish). Questionnaire was targeted by a random sample so that it considered a real wind power plant and real project plans in Finland. Background of the respondent was examined and the fact if the respondent was able to see the planned wind power plant from his property. As an appendix of the questionnaire a report about the wind power plant and its details was delivered to the respondents so that they were able to relate their own positions toward the project.

The key questions focus on each:

- project area and the familiarity of the respondent with and the use of the area
- experiences of the respondent on wind power plants
- attitude of the respondent toward different energy production modes
- views of the respondent on the current stage of their living environment, the project and its impacts
- background information of the respondent.

Questionnaire was constructed with the help of TEA-model so that the sub-groups of acceptance (A) factors, which are required for external acceptance, were analysed from the standpoint of wind power projects.

Planned wind power plants are located in an area, where there already exists a component industry that focuses on energy production. This means that the research focuses on areas where there already are wind power related jobs even though there is not a lot of wind power production.

4 Results and analysis

This research was conducted in Finland, in the area of western Finland, where the wind power industry has mainly focused. The results of the research form around nine different wind power projects. People for this research were selected by a random sample selection and a standardised questionnaire was used in order to raise the quality of the answers.

The questionnaires were delivered by a random sample to households located near the project areas in spring and summer 2009. 2,782 persons answered the questionnaire; answering percentage was 30%. 39% of the respondents were females and 61% males. The most active age group was 51–65 years old.

The answers were gathered concerning both land and offshore wind power projects. Land wind power projects were quantitatively more but unit sizes were smaller than in offshore wind power projects. The impact factors were divided into positive and negative impacts. The questionnaire was conducted in a two-way manner so that the respondent was able to determine the level of negative or positive response.

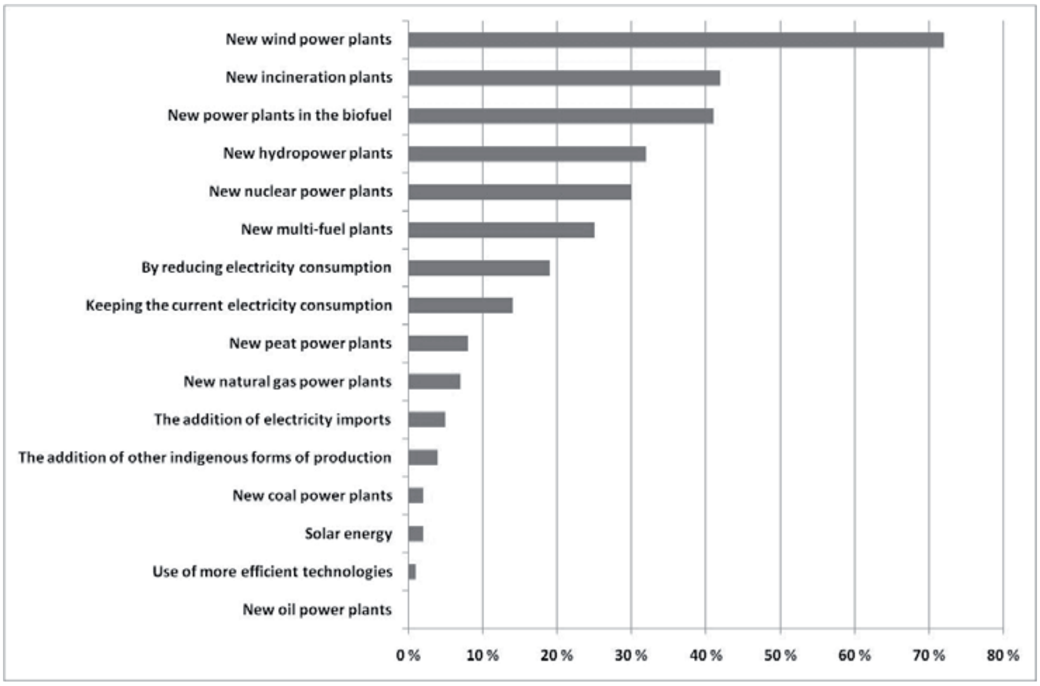
In examining the positive impacts of wind power plants, separate surveys were made considering the impacts on image and economy of the city, employment rate and climate change. The results were compared between two groups; the respondents who have direct view to the wind power plants and the respondents who have not.

One interesting fact is that on the base of the research results the respondents expect that wind power plants have relatively more positive impact on the image and economy of the city and employment rate than on climate change. Other significant fact is that the direct view to the wind power plant has no remarkable significance when analysing the positive impacts.

Respectively when analysing negative impacts of wind power plants based on landscape, birdlife, cultural environment, residential satisfaction and noise it can be seen that the negative impacts accentuate among the respondents who have direct view to the plant. The negative impacts are largest among birdlife and landscape.

In addition to negative and positive impacts the respondents were asked how energy should be produced in the future in Finland. The citizens would like to have new wind power plants (72%), new incineration plants (42%) and new power plants in biofuels (41%) (Figure 3).

Figure 3 The desired way to produce future energy in Finland (n = 2534)



When reviewing energy production in Finland on a general level, the respondents had the chance to comment energy production in general and therefore, the weight towards the nearby designed wind power plant decreased. The results show that wind power is supported in general but not so strongly in nearby areas.

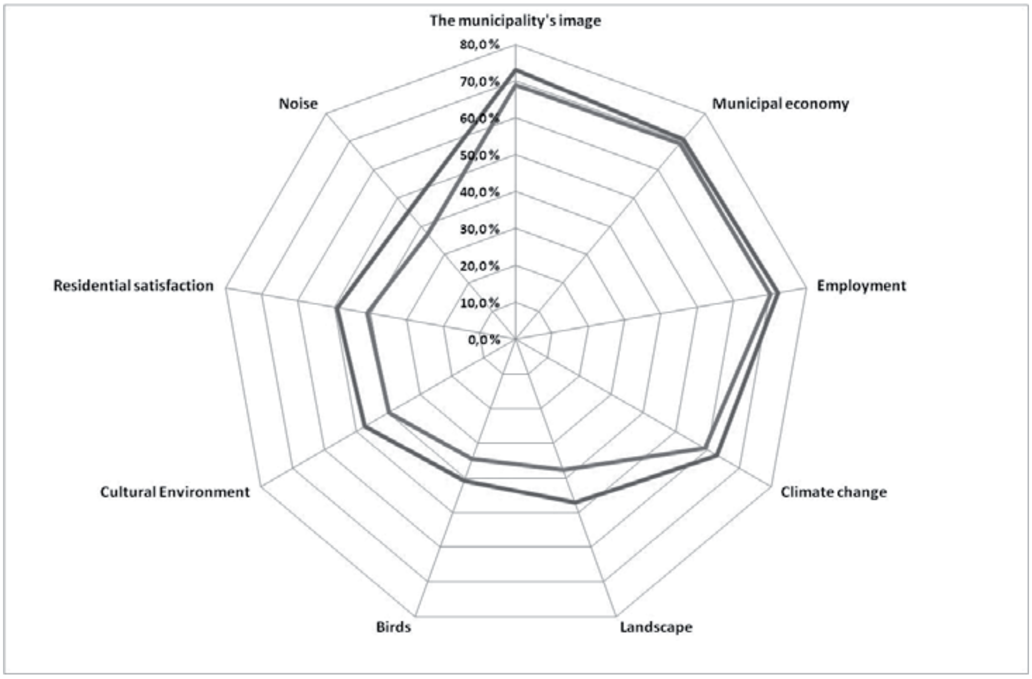
When accounting the acceptance (A) factor, which is a precondition for realisation of wind power plants, a clear connection is found between the two respondent groups: the ones who have direct view to the plant and the ones that have not. The location of the plant clearly has an effect on the attitude of the respondent towards the plant.

The accounting was implemented by transferring the responses of acceptance factors into numerical form:

highly negative	0
rather negative	0.25
no effect	0.5
rather positive	0.75
highly positive	1

Based on the responses a weighted average of acceptance factors was calculated between two different respondent groups.

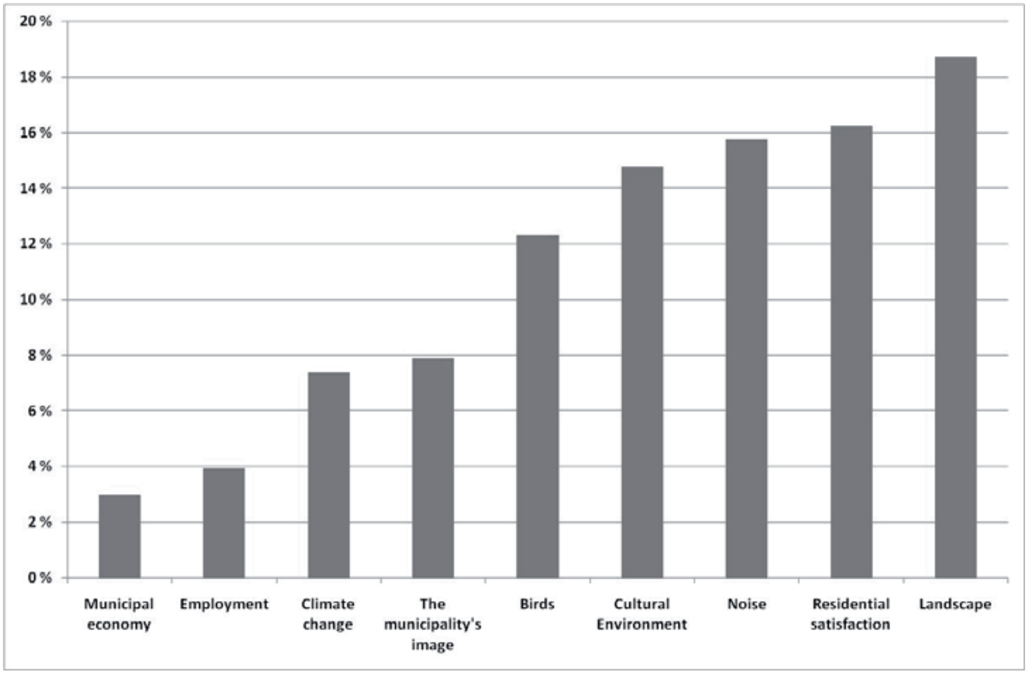
Figure 4 Differences on acceptance factors of wind power between the respondent groups who live nearby the project area who have not direct view to the project area (outer line) and who have direct view to the wind power plant (inner line)



According to the research, 72% of the respondents support wind power on a general level (compare Figure 3). Respectively when examining the acceptance factors among the group who live nearby the wind projects the support rate is 56.7% and 50.9% among those who have direct view to the project area (Figure 4). Significant fact is that when reviewing group who have direct view to the project area, the impacts were seen more negative in every single acceptance factor.

When reviewing the relative differences of the results between two different respondent groups, especially the impacts on landscape, residential satisfaction and noise come up. Irrespective of the respondent group the impacts on employment and municipal economy are seen parallel within both groups. Figure 5 clarifies the relative differences in the answers of two respondent groups: the ones who have direct view to the planned plant and the ones who have not.

Figure 5 The relative difference of respondent groups on different impacts



According to the research results it can be seen that general acceptance for building wind power is on a relatively high level in Finland. The closer to the planned wind power plant people live the more the acceptance rate decreases.

Hence, on the grounds of the research results the original TEA-model formula $F(x) = T(x) * E(x) * A(x)$ can be defined so that factor $A(x)$ is dependent on the population rate in the area where wind power construction is being planned at. The effect of this factor can be reduced by legislative control.

Respectively economical means [factor $E(x)$] can be utilised in growing wind power construction. This means for example better ability to pay compensation for the people that are harmed by the project.

5 Evaluation of results and further research

At the moment wind power is something quite new in Finland. Finland has the 13th least installed wind power in Europe in 2008. The current energy and climate politics support the increase of renewable energy sources in EU and also Finland.

The results of the research are based on vast questionnaire partly conducted in areas in where there are plans for wind power parks. Based on the results it can be seen that Finns are ready for building of wind power, especially in cases where the plant is not planned in the nearby area of their property.

The research material was gathered by mail delivered questionnaire. In this research citizens were asked on their opinions about the wind power by several different questions. The research is partly quantitative and partly qualitative.

When reviewing the quantitative part of the research the validity and reliability of the methodologies of information gathering are crucial for research results. In this research the reliability was raised by measuring the same factor with several variables. Special attention was paid to most crucial factors, which delivered new scientific information for scientific discussions. Validity was tested by using evaluations of experts in the industry on how the asked questions measure the examined factor.

In wind power industry innovation TEA-model equation $F(x) = T(x) * E(x) * A(x)$ means that wind power construction comes possible if the building process is technically possible, if economical conditions are met and the project has general acceptability. Some of the factors in the equation can be disregarded on the grounds of legislative obligations and authorisations.

It can also be presumed that same wind power technology is available everywhere. Therefore, it does not explain differences in wind power construction between countries (see Figure 1). Hence, TEA-model equation can be simplified into form $F(x) \sim E(x) * A(x)$. The acceptability factor $A(x)$ of the equation is dependent on the population rate in the project area and the country's legislation. With economical factor $E(x)$ it is possible to influence on factor $A(x)$, so that the conditions for the investment are met.

Possibilities for further research are deepening the research results and improving the quality by conducting the surveys on every area where there are plans for wind power parks in Finland. It is also possible to widen the research by making international comparison between different countries.

6 Conclusions

The main outcome of the research was to find the relation between framework factors affecting the acceptability of wind power investment and the other decision-making factors affecting the investment preconditions. The examination was made on three different levels: by examining the general acceptance of wind power, the acceptance in areas where wind power parks are planned and the attitude of those who have direct view to the planned park.

The goals that were set for the research were achieved. Based on the research it was found out that in a country where there is little wind power relative to surface area, the attitude towards wind power is mainly positive. The closer to the planned plant people live, the more the positive attitudes decrease. On deciding on the international emission reduction not only economical factors should be taken into account but also the impacts of general acceptance of wind power. Acceptability of building wind power will change after more wind power has been built in the country in question and hence, the citizens get to see and experience the effects of wind power plants. These are effects on landscape and noise levels in the area.

The research results help decision makers to learn the piece of the framework around building wind power and especially in Finland. On the basis of the results the investors in the energy field can learn, innovate and asses the feasibility of investment projects related to wind power. Respectively country/municipality level decision makers can learn and perceive entirety that surrounds wind power acceptability. The research is a contribution to science because they fulfil the goal that was set for this research and the research results fulfil scientific debate on construction of energy production modes, especially wind power, from investors' point of view. This work links also to the existing scientific research.

In the future the research can be broadening to cover different countries. Comparison can also be made within the country in relation to time and examine more deeply how $E(x)$ and $A(x)$ are dependent on each other in different countries at different times.

References

Afgan, N. and Carvalho, M. (2002) 'Multi-criteria assessment of new and renewable energy power plants', *Energy*, Vol. 27, pp.739–755.

Afgan, N. and Carvalho, M. (2004) 'Sustainability assessment of hydrogen energy systems', *International Journal of Hydrogen Energy*, Vol. 29, pp.1327–1342.

Anthoff, D. and Tol, R. (2008) 'On international equity weights and national decision making on climate change', Cesifo working paper no.2373, Presented at *Cesifo Venice Summer Institute 2008, Workshop on Europe and Global Environmental Issues.*

Arbnor, I. and Bjerke, B. (1997) *Methodology for Creating Business Knowledge*, Sage Publications, London.

Blok, K. (2005) 'Enhanced policies for the improvement of electricity efficiencies', *Energy Policy*, Vol. 33, pp.1635–1641.

COM (2006) 'Green paper, a European strategy for sustainable, competitive and secure energy', Commission of the European Communities.

COM (2007) 'An energy policy for Europe', Commission of the European Communities.

Eltham, D., Harrison, G. and Allen, S. (2008) 'Change in public attitudes towards a Cornish wind farm: implications for planning', *Energy Policy*, Vol. 36, pp.23–33.

Eurostat (2009) 'Europe in figures', *Eurostat Yearbook 2008*, Belgium.

EWEA (2009) 'Winning with European wind, creating power, helping the environment', EWEA 2008 Annual Report, Brussels, Belgium.

Hirsjärvi, S. and Huttunen, J. (1995) *Johdatus Kasvatustieteeseen*, 4th ed., *WSOY* (in Finnish), Porvoo, Helsinki, Juva.

Holdren, J. and Ehrlich, P. (1974) 'Human population and the global environment', *American Scientist*, Vol. 62, pp.282–292.

Holttinen, H. and Stenberg, A. (2009) 'Wind energy statistics of Finland', Yearly report 2008', VTT Working Papers 132.

International Energy Agency (2008) *World Energy Outlook 2008*, Paris, France.

Kasanen, E., Lukka, K. and Siitonen, A. (1993) 'The constructive approach in management accounting research', *Journal of Management Accounting Research*, Vol. 5, pp.241–264.

Lior, N. (1997) 'Advanced energy conversion to power', *Energy Conversion and Management*, Vol. 38, pp.941–955.

Lior, N. (2002) 'Thoughts about future power generation systems and the role of energy analysis in their development', *Energy Conversion and Management*, Vol. 43, pp.1187–1198.

Lund, H. (1999) 'Implementation of energy-conservation policies: the case of electric heating conversion in Denmark', *Applied Energy*, Vol. 64, pp.117–127.

Lund, H. (2007) 'Renewable energy strategies for sustainable development', *Energy*, Vol. 32, pp.912–919.

Neilimo, K. and Näsi, J. (1980) 'Nomoteettinen tutkimusote ja suomalainen yrityksen taloustiede, tutkimus positivismin soveltamisessa', Yrityksen taloustieteen ja yksityisoikeuden laitoksen julkaisuja, sarja A 2: 12 (in Finnish), University of Tampere, Tampere.

Niiniluoto, I. (1996) 'Teknologiapolitiikka, arvot ja kansalaiset', *Tiedepolitiikka*, Vol. 4, pp.37–44 (in Finnish).

Waggoner, P. and Ausubel, J. (2002) 'A framework for sustainability science: a renovated IPAT identity', *Proceedings of the National Academy of Sciences*, Vol. 99, pp.7860–7865.

Wolsink, M. (2007) 'Wind power implementation: the nature of public attitudes: Equity and fairness instead of backyard motives', *Renewable and Sustainable Energy Reviews*, Vol. 11, pp.1188–1207.

York, R., Rosa, E. and Dietz, T. (2003) 'STIRPAT, IPAT and ImPACT: analytic tools for unpacking the driving forces of environmental impacts', *Ecological Economics*, Vol. 46, pp.351–365.