

Assessing the Market Attractiveness for a Renewable Energy Source

- A case study of the expanding wind power market in Finland
-

Authors: Carl Fredrik Leifland
Christoffer Löfquist

Supervisors: Elisabet Wahlstedt
Bertil I Nilsson - Faculty of Engineering



LUND UNIVERSITY

Preface

This master thesis is our final project and thus the end of our master's studies of Industrial Engineering and Management, at the Faculty of Engineering, Lund University. To apply our acquired knowledge on a reality based case during this spring has been challenging, interesting and rewarding.

We would especially like to thank our supervisor Elisabet Wahlstedt and her colleagues who have been most helpful providing us with information and guidance.

We would also like to thank our academic supervisor Bertil I Nilsson who has believed in us all the way and inspired us in times of doubt as well as given a lot of helpful guidance. Finally - a huge thank you to Marcus Bruzelius and Oscar Werne for their valuable feedback and improvement suggestions when assuring the quality of our thesis.

Lund 2014-06-05

Carl Fredrik Leifland
Christoffer Löfquist

Abstract

Title	Assessing the market attractiveness for a renewable energy source – A case study of the expanding wind power market in Finland
Authors	Carl Fredrik Leifland and Christoffer Löfquist – Master of Science in Industrial Engineering and Management
Supervisors	Elisabet Wahlstedt Bertil I Nilsson – Associate Assistant Professor, Department of Industrial Management and Logistics, Lund University, Faculty of Engineering
Background	The EU's 20-20-20 targets determine that Finland's share of energy consumption from renewable energy sources is to be 38 % by 2020, a target that the government intends to reach by expansion of wind power. The government has a beneficial feed-in tariff in place as an incentive for rapid wind power expansion, which has made both domestic and international developers evaluate the business case in Finland.
Purpose	The purpose of the study is to assess the attractiveness of wind power in Finland and determine the viability for a potential market entry.
Objective	The objectives of the study were: <ul style="list-style-type: none">• Examine existing framework to assess attractiveness of a geographical market for a renewable energy source.• Map the current market structure and the key drivers.• Evaluate the Finnish business case to conclude the potential viability of the market.
Methodology	An exploratory approach was used to establish a framework to perform the case study on the wind power market in Finland. Both a descriptive and a predictive approach were later used when applying the framework onto the market.

The concluding evaluation then followed an explanatory approach as the interaction of different factors determined the outcome of the conclusion.

Conclusions The thesis' developed CL²-model is deemed to be an appropriate framework to assess the wind power market in Finland, and quite possibly applicable onto other geographical markets and weather dependent renewable energy sources. The case study of Finland indicates that there are viable business opportunities for actors interested in acquiring projects as brand new projects are predicted not to be included in the current subsidy system. The financial evaluation indicates an internal rate of return of at least 6.5 %, given the assumptions made in the financial model. Main risks to consider are political interference causing a decrease in the subsidy system and stricter noise regulations.

Key words: Finland, wind power, feed-in tariff, weather dependent renewable energy source, business case evaluation, 20-20-20 targets

Sammanfattning

Titel	Marknadsattraktivitetsbedömning för en förnybar energikälla – En fallstudie av den expanderande vindkraftsmarknaden i Finland
Författare	Carl Fredrik Leifland och Christoffer Löfquist – Civilingenjörer inom Industriell ekonomi
Handledare	Elisabet Wahlstedt Bertil I Nilsson – Adjungerad universitetslektor, Avdelningen för Produktionsekonomi, Lunds Tekniska Högskola.
Bakgrund	EU:s 20-20-20 mål fastslår att Finlands andel av förnybar energi ska vara 38 % av den totala energikonsumtionen år 2020. Den finska regeringen avser att nå detta mål genom utbyggnad av vindkraft. För att påskynda utbyggnaden har regeringen infört ett generöst inmatningspris som incitament för utvecklare. Det har lett till att både nationella och internationella utvecklare börjat utvärdera affärsmöjligheterna i Finland.
Syfte	Syftet med studien är att utvärdera attraktiviteten hos vindkraft i Finland och bedöma lönsamheten för ett potentiellt marknadsinträde.
Mål	Målen med studien var att: <ul style="list-style-type: none">• Undersöka existerande ramverk för att utvärdera en förnybar energikällas marknadsattraktivitet.• Kartlägga den nuvarande marknadsstrukturen och drivkrafterna.• Utvärdera affärsmöjligheterna i Finland för att dra slutsatser om marknadens potentiella lönsamhet.
Metodik	En explorativ ansats användes för att etablera ett ramverk att använda i fallstudien på vindkraft i Finland. Därefter användes en kombination av beskrivande och predikterande ansats vid tillämpningen av ramverket på

marknaden. Den avslutande utvärderingen följde en förklarande ansats då samverkan mellan olika faktorer låg som beslutsunderlag för det slutliga utfallet av slutsatsen.

Slutsats

Den utvecklade CL²-modellen bedöms vara ändamålsenlig för att utvärdera vindkraftmarknaden i Finland, och fullt möjligt tillämpbar på andra geografiska marknader och/eller väderberoende förnybara energikällor. Fallstudien på Finland indikerar att det finns lönsamma affärsmöjligheter för aktörer med intresse att förvärva projekt då nystartade projekt predikteras att inte hinna bli inkluderade i det nuvarande stödsystemet. Den finansiella utvärderingen indikerar en avkastning på minst 6.5 % givet de antaganden som gjorts i den finansiella modellen. De primära riskerna anses vara en politisk orsakad minskning av stödsystemet samt striktare bullernivåer.

Nyckelord: Finland, vindkraft, inmatningspris, väderberoende förnybar energikälla, affärsmöjlighetsutvärdering, 20-20-20 mål

Table of Contents

1	Introduction	1
1.1	Background.....	1
1.2	Problem analysis	5
1.2.1	Weather-dependent renewable energy sources (WDRES).....	5
1.3	Purpose	6
1.4	Delimitations.....	7
1.5	Target group.....	7
1.6	Report outline.....	8
2	Methodology	11
2.1	Methodology approach.....	11
2.2	Research strategies	11
2.3	Data collection.....	12
2.3.1	Written questionnaire.....	13
2.3.2	Direct observations	13
2.3.3	Interviews.....	13
2.4	Sampling	14
2.5	Qualitative and quantitative data.....	15
2.6	Credibility.....	15
2.6.1	Achieving credibility.....	16
2.7	Chosen method	16
2.7.1	Criticism of chosen method.....	18
2.8	Research process.....	19
2.9	Source criticism	20
3	Theoretical framework.....	21
3.1	Theoretical approach	21
3.2	Mapping the macro-environment	22
3.2.1	Political.....	22
3.2.2	Economic.....	23

3.2.3	Social.....	23
3.2.4	Technological	23
3.2.5	Environment.....	24
3.2.6	Legal.....	24
3.3	Analysing the industry.....	24
3.3.1	Threat of new entrants.....	25
3.3.2	The power of suppliers	27
3.3.3	The power of buyers	27
3.3.4	Threats from substitutes.....	28
3.3.5	Rivalry among existing competitors.....	28
3.4	Strategic decision making.....	29
3.4.1	Criticism	31
3.5	Project life cycle.....	31
3.5.1	XLPM.....	31
3.5.2	Project steering process	32
3.5.3	Project management process	34
3.5.4	Project Work Model.....	35
3.6	Investment capital budgeting	35
3.6.1	The time value of money.....	35
3.6.2	Net present value - NPV.....	36
3.6.3	Internal rate of return- IRR.....	37
3.6.4	Combining NPV and IRR.....	37
3.6.5	Levelised cost of energy – LCOE.....	38
3.6.6	Weighted Average Cost of Capital – WACC.....	38
3.7	Wind power theory	39
3.7.1	Energy conversion	39
3.7.2	Turbulence	40
4	Model.....	41
4.1	Market assessment.....	42

4.2	WDRES Lifecycle.....	44
4.2.1	Analysis.....	45
4.2.2	Planning.....	46
4.2.3	Execution - Establishment.....	47
4.2.4	Execution - Realisation.....	48
4.2.5	Execution – Hand-over.....	48
4.2.6	Generation.....	49
4.3	Evaluation	49
4.3.1	Qualitative analysis.....	49
4.3.2	Quantitative analysis.....	50
5	Case study - Finland.....	53
5.1	Market assessment.....	53
5.1.1	Global.....	53
5.1.2	Finland	57
5.1.3	Energy	62
5.1.4	Wind power	72
5.2	The Finnish onshore wind power life cycle	93
5.2.1	Analysis.....	94
5.2.2	Planning.....	98
5.2.3	Execution – Establishment	108
5.2.4	Execution – Realisation.....	112
5.2.5	Execution – Handover	116
5.2.6	Generation.....	118
5.2.7	Summary of costs	122
6	Evaluation.....	123
6.1	Quantitative analysis	123
6.1.1	Analysis phase (m=1)	124
6.1.2	Planning phase (m=2)	124
6.1.3	Establishment phase (m=3)	124

6.1.4	Realisation phase (m=4).....	124
6.1.5	Hand-over phase (m=5).....	124
6.1.6	Generation phase (m=6).....	125
6.1.7	Reference project	126
6.2	Qualitative analysis	129
6.2.1	Global.....	129
6.2.2	Finland	130
6.2.3	Energy	132
6.2.4	Wind power	133
6.2.5	The project-life cycle.....	137
6.3	Sensitivity analysis	139
7	Conclusions	141
7.1	Investment recommended, but not risk free	142
7.2	Contribution.....	142
8	Final remarks.....	145
8.1	Suggestions for further research.....	145
8.2	General applicability of the results and model	145
	References	147
	Appendix 1: Developer survey	1
	Appendix 2: Interview questionnaire.....	1
	Appendix 3: Excerpts from financial evaluation	1

Table of figures

Figure 1: The preliminary total energy consumption in Finland 2013	3
Figure 2: Electricity consumption by different energy sources in Finland	4
Figure 3: The research process.....	20
Figure 4: The PESTEL framework	22
Figure 5: Porter's five forces model.....	25
Figure 6: The SWOT matrix.....	30
Figure 7: XLPM's project life cycle model.....	32
Figure 8: XLPM's tollgate decision making process.....	33
Figure 9: The CL ² -model.....	41
Figure 10: The MA pyramid	43
Figure 11: The life cycle of a WDRES.....	45
Figure 12: A map of Finland and its main regions.....	57
Figure 13: Electric supply 1970-2012	64
Figure 14: Electricity generation with renewables 2000-2012.....	65
Figure 15: The Nordic power system, price and flow at 17.08 2014-03-03.....	68
Figure 16: The historic spot price on Nord Pool in Finland.....	69
Figure 17: Prognosis of the future spot price in Finland	71
Figure 18: The FIT described with Finnish electricity prices from 2013	76
Figure 19: Total installed capacity as of May 2014 [MW]	79
Figure 20: The largest actors and project clusters.....	81
Figure 21: The Finnish main transmission grid.....	85
Figure 22: To the left: Annual average wind speed (m/s) at 100 m To the right: Annual average electricity production (MWh) at 100 m	88
Figure 23: The project pipeline up until 2015	89
Figure 24: The project life cycle of onshore windpower in Finland.....	94
Figure 25: Onshore wind power tendering process	110
Figure 26: Spot price prognosis in price area Finland.....	128
Figure 27: Estimation of when the FIT system is full.....	134

Table of tables

Table 1: The proposed 2030-targets on EU-level	56
Table 2: Finland's national and climate targets.....	62
Table 3: Overview of the nuclear reactors in Finland	65
Table 4: Installed wind capacity in the FIT system as of May 2014.....	80
Table 5: Project pipeline after 2015.....	89
Table 6: Fingrid's grid development plan 2012-2022	91
Table 7: Cost structure of a typical 3 MW wind turbine.....	115
Table 8: Fingrid's Grid connection solutions and fees 2014	115
Table 9: Grid service fees 2014 in Fingrid's transmission grid.....	121
Table 10: Summary of main costs during the project process	122
Table 11: Comparison of the same project started at different times.....	128
Table 12: Project pipeline with estimated time of commencing operations..	134

Abbreviations and definitions

Brownfield	-	A project from TG1-TG3
CAPEX	-	Capital Expenditures
CCS	-	Carbon Caption and Storage
CO ₂	-	Carbon dioxide
EA	-	Energy Authority
ECB	-	European Central Bank
EIA	-	Environmental Impact Assessment
EOW	-	End-of-warranty
GHG	-	Green House Gases
Greenfield	-	A project at TG0
IEA	-	International Energy Agency
IPCC	-	Intergovernmental Panel on Climate Change
IRR	-	Internal Rate of Return
ITT	-	Invitation to tender
LCOE	-	Levelised Cost of Energy
NDA	-	Non-disclosure agreement
NPV	-	Net Present Value
O&M	-	Operation & Maintenance
OEM	-	Original Equipment Manufacturer
OPEX	-	Operational Expenditures
PLCM	-	Project Life Cycle Model
R&D	-	Research & Development
RES	-	Renewable Energy Source
TG	-	Tollgate
WACC	-	Weighted Average Cost of Capital
WAsP	-	Wind Atlas Analysis and Application Program
WDRES	-	Weather Dependent Renewable Energy Source
XLPM	-	Excellence in Project Management

Units

MWe	-	Megawatt electricity
Wh	-	Watt-hour = 3600 Joule
VA	-	Volt-ampere – the <i>apparent power</i> in an electrical circuit

1 Introduction

This chapter introduces the background of this study and briefly mentions the drives and incentive to explore Finland's wind power sector. The purpose and problem analysis is presented to allow the reader to gain understanding of the study's objectives before winding up with delimitations and the target group.

1.1 Background

The issue of global warming and climate change has been widely discussed over the last decades and several international organisations have been created due to this cause. Meanwhile, climate sceptics have worked in counter-organisations against the claim of anthropological influence. In the fifth (and latest) report from the Intergovernmental Panel on Climate Change (IPCC) the panel states that it is "*extremely likely [95 percent confidence] more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together*"¹, thus virtually ensuring that humankind is responsible for climate change.

Two of the main sources of greenhouse gases (GHG) emissions are electricity production and transportation. Both sectors' emissions primarily come from combustion of fossil fuels. The energy production of fossil fuels can be traced back hundreds of years and is considered one of the main factors behind the industrial revolution. The dependence of fossil fuels, which are a finite source of energy, is a significant political power factor impacting society on a global level. This is one of many reasons why alternate energy sources have developed over the last centuries like hydro or nuclear power.

In the most western countries, both collaborative unions like the EU and individual nations have recognised that the GHG emissions level are too high and thus created legislations and incentives to lower them. This has led to a rapid expansion of renewable energy sources (RES) like wind and solar power as well as increased R&D within renewable energy. To promote the expansion of RES most countries offer the producers some kind of subsidy as investments in RES have difficulties to break-even. The government in Finland recently initiated an ambitious feed-in tariff system for wind power and plants fuelled with biogas, forest chips and wood-based fuels² that has enticed a few

¹ (IPCC, 2013)

² (Finland's Ministry of Employment and the Economy, 2013)

Swedish wind power developers to enter the wind power market in Finland. This decision has incited other actors on the Swedish wind power market, where the green certificate system is the incentive to pursue profits, to evaluate the business case in Finland.

The climate changes have forced the world's governments to implement preventative measures, like the Kyoto Protocol. However, not all governments acknowledge the situation or are willing to sign binding agreements to lower GHG emissions. In an attempt to be the role model for the rest of the world, the European Union (EU) has legislated an ambitious energy and climate policy. In 2007 the EU introduced the 20-20-20 targets, which consists of three main objectives to be reached by 2020³:

- Reduce GHG emissions by 20 % from 1990's level.
- Improve energy efficiency by 20 %.
- Increase share of energy produced with renewable resources to 20 % of the final energy consumption.

The targets were set for the entire union. However, differentiated targets were developed for each country in the case of objective three, this to equalize the burden between all nations as some countries already met the quota. For example Finland, where hydro plants and power plants combusting biomass fuels already produced over 20 % of the national energy consumption. Thus, Finland's target was set to 38 % by the EU⁴.

³ (European Commission, 2014a)

⁴ (Finland's Ministry of Employment and the Economy, 2013, p. 7)

Energy consumption 2013

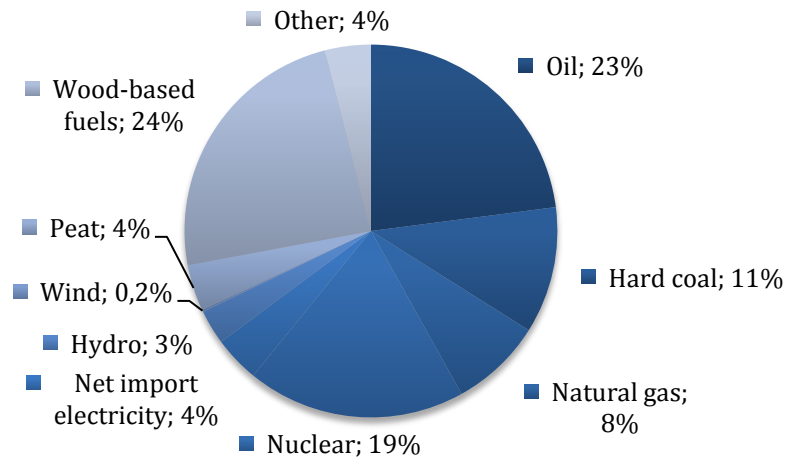


Figure 1: The preliminary total energy consumption in Finland 2013⁵

The share of renewables (hydro, wind and wood-based fuels) was approximately 28 % of the total energy consumption, thus falling 10 % short of the 2020-target. As seen in figure 1 above, Finland net imports almost 4 % of the consumed energy, which corresponds to ~19 % of the consumed electricity in Finland⁶. The electricity mix for 2012 is shown in figure 2 below (the statistics of 2013 were incomplete at the time the study was published):

⁵ (Official Statistics of Finland (OSF), 2014a)

⁶ IBID

Electricity consumption by energy source 2012

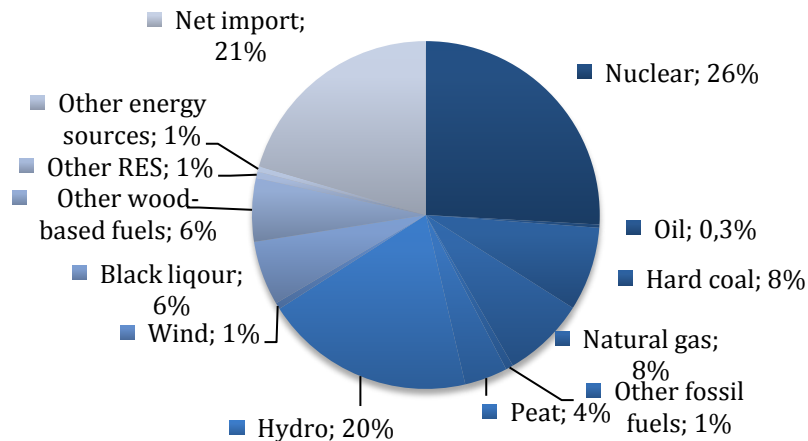


Figure 2: Electricity consumption by different energy sources in Finland⁷

As seen in figure 2, the share of fossil fuels has greatly decreased in comparison with other energy sources. It is worth noticing how hydro power's share of the energy consumption is only 4 %, while in electricity production is around 20 %. The overall share of renewables in the electricity consumption is slightly higher than in the energy consumption. Since Finland still has some way to go to meet the 38 % quota it is noteworthy that a new nuclear reactor is under construction and supposed to begin commercial operation in 2016. This will increase the installed nuclear capacity by 58 % (2740 MWe installed today and the new reactor is 1600 MWe) and thus affect the production mix significantly⁸. Also, Finland is dependent on electricity imports, since a few years back mainly from Sweden, as the current national production corresponds to roughly 80 % of the final consumption. The National Energy and Climate Strategy put emphasis on the importance to become self-sufficient, which intends to be accomplished by the new reactor (and another two in the project pipeline) and continued expansion of especially wind power.

Figure 2 states that wind power accounts for less than one percent of the production 2012 which corresponds to ~0.5 TWh. In 2013 the production

⁷ (Official Statistics of Finland (OSF), 2013)

⁸ (World Nuclear Association, 2014)

grew rapidly to ~0.8 TWh. As the official political target for 2020 is 6 TWh, a substantial gap and opportunity is recognised for industry growth⁹. The Finnish government introduced a generous feed-in tariff system in 2011 to strengthen the incentives for wind power expansion, which has made the national business case of interest to further evaluate.

1.2 Problem analysis

The expansion of renewable energy is soaring over the globe, making different kinds of stakeholders take interest in new geographical markets which seem to have great potential. However, the energy market is unique in many ways, for instance its extremely politicised and in many parts of the world nationalised. Depending on which market, or RES, a developer will face different issues to enter a market. Transmission grids over the globe are unevenly integrated due to this, but the EU is pursuing a target of total grid integration which impacts Finland and its electricity market. Also to consider, there are also several different ways to transform energy and electricity so that it can be used in society. Combustion, nuclear, renewables – all of them have pros and cons in regard to both economic and environmental factors. Also, the market is close to perfect competition, thus the supply and demand deciding the spot price making the electricity producers vulnerable to sudden demand changes.

Wind power in Finland shows promising potential due to the newly introduced feed-in tariff system combined with the political target to increase the produced electricity from wind farms by a factor of 12 over the next six years. To determine whether it actually poses a prospective market, information about what drives the industry and current market situation must be collected and analysed. All phases of the lifecycle of a wind farm must also be investigated to explore different actors on the market, legal implications, and probable timeframes for each phase. Lastly, the costs and revenues related to a wind farm must be described to assess the financial viability of a project.

1.2.1 Weather-dependent renewable energy sources (WDRES)

Most RES share similar traits compared to other energy sources and industries:

⁹ (Finland's Ministry of Employment and the Economy, 2013, p. 33)

- A capital-intense business with often lengthy timeframes for project delivery.¹⁰
- Almost negligible life cycle GHG-emissions compared to traditional energy sources.¹¹

Different RES' may be categorised according to their relation with weather/climate variability¹²:

- Not affected: Geothermal and tidal energy.
- Somewhat affected: Bio energy and hydro power are related to weather on a seasonal time scale.
- Directly affected: Wind power, photovoltaic, solar thermal and other solar concentrated power resources correlates perfectly with fluctuating weather conditions.

Hence, the directly affected RES are weather-dependent. Other traits this particularly category share is:

- Fixed O&M-costs and low variable O&M-costs (particularly due to repairs and spare parts)

No anthropologically induced fuel keeps the variable O&M-costs at minimum.¹³

1.3 Purpose

The purpose of the study is to explore the current theories of assessing the attractiveness of a new market for a developer within renewable energy sources. Finland's gratuitous feed-in tariff system for wind power combined with ambitious political goals make the market attractive to explore for domestic and international wind power developers. Thus another purpose is to determine if there are viable business conditions for a developer to enter the Finnish wind power market.

The information needed may be obtained through examining the answers of a few questions.

¹⁰ (Fontana, et al., 2012; EIA, 2013)

¹¹ (Sovacool, 2008)

¹² (von Bremen, 2010)

¹³ (EIA, 2013)

- How should a RES developer assess the attractiveness of a new market?
- Are there viable business opportunities to enter the Finnish wind power market?
 - What is the market structure today?
 - What are the key drivers?
 - Which are the essential risks?

By answering these questions thoroughly a developer should have the appropriate information to either pursue or leave a potential market. Compressing the answers of the questions are however appropriate as the answers most likely interlace one another.

1.4 Delimitations

Every nation has their own bureaucracy and permit process, thus a somewhat generalizable model has to be seen as a framework and not a step-by-step map to assess any market. The study will focus on well-developed markets like the Nordic, but will still be applicable to assess any geographical market.

Wind is a dynamic phenomenon and its unpredictability affects the confidence level of the study. The study will rely on wind maps based on the purely statistical WAsP-model, which does not include any actual wind measuring.

The Finnish electricity market is part of Nord Pool Spot Exchange and interconnected with the Nordic and Baltic countries. Despite the size of the marketplace, the spot price is highly volatile and highly correlated with seasonal variations. The uncertainties of the future spot price will be dealt with by assessing and comparing different Nordic actors' long term prognosis.

The study will not cover the funding of RES projects in any way due to the stretch of financial capabilities depending on the developer.

1.5 Target group

The business perspective of the study especially targets stakeholders within the energy industry, especially companies within the wind industry whom consider Finland to be a market worth exploring. The study does approach the industry from a developer's point of view. The academic perspective addresses graduate students and academics in engineering, but also economics and environmental sciences due to the possible applications of the findings.

1.6 Report outline

Chapter 1: *Introduction* – This chapter introduces the reader to and sets the scope of the study. It starts with the background of renewable energy targets and why Finland has chosen to expand in wind power. This is followed by the problem analysis in which the WDRES concept is introduced. The purpose of the study is stated together with the main questions the study is to answer. The study's delimitations and target group is also explained.

Chapter 2: *Methodology*– This chapter starts by describing available and applicable methods and research strategies. Further on the chosen method is described in depth. At the end the research process is outlined and criticism of the chosen method and sources are included.

Chapter 3: *Theoretical framework* – This chapter describes available theories for analysis of a WDRES market. It includes models for analysis and mapping of the; macro environment, the industry, strategic decision making and the project life cycle. Towards the end of the chapter several widely used models for investment capital budgeting are explained and the last subchapter gives a theoretical background of wind power.

Chapter 4: *Model* – This chapter introduces the developed CL²-model. The model was developed as the theories in the chapter 3 were found to generic and in need of modification to be used on markets for WDRES. The model includes market assessment, analysis of the RES-lifecycle and quantitative and qualitative evaluations all explain in detail. The RES-lifecycle is divided into five sub-phases; analysis, planning, execution – establishment, execution – realisation, execution – hand-over and generation.

Chapter 5: *Case study - Finland* – In this chapter the CL²-model is applied for analysis of the Finnish wind power market. Firstly a market assessment for four levels; global, Finland, energy and wind power is conducted by analysing each level for; as/is, future and risks. The second part of the chapter outlines the process of building in wind power and describes each sub-phase listed in the last paragraph by analysing; activities, stakeholders, financial, future and risks.

Chapter 6: *Evaluation* – This chapter evaluates the findings for the Finnish wind power market presented in chapter 5 with CL²-model. First a quantitative evaluation is conducted by applied the capital investment theories to a Finnish wind power project. The second part is a qualitative

analysis of several levels and the project-life cycle. The chapter is ended by a sensitivity analysis.

Chapter 7: *Conclusion* – This chapter presents the conclusions and answers the main questions stated in the purpose. It reveals under which circumstances an investment in Finland is recommended and which the essential risks are. It also states the study's main contributions.

Chapter 8: *Final remarks* – In this chapter suggestions for further research is presented together with a discussions and comments on the general applicability of the results in the study.

2 Methodology

The methodological choices made in the study are presented in this chapter, along with some generic theories concerning the subject. The chosen methodological approach is presented at the end of the chapter, including the research process and a critical discussion about the choice of approach.

2.1 Methodology approach

In the beginning of a study a methodology is determined. The purpose of the methodology is to present a general idea about the approach the researchers will use when conducting the study without in detail explain every step of the process.¹⁴

A study's research purpose and objectives influence its methodological approach. An *exploratory approach* is used to look into an area with limited knowledge to gain fundamental understanding of the subject. When the objective is to merely describe a field and state facts about it, without explaining why things are in a certain way, a *descriptive approach* can be used. When the objective is to more deeply look into a field and explain how factors interact and affect each other or to answer the question of why something occurs an *explanatory approach* can be used. A *predictive approach* is used to give a prognosis or predict what will likely happen in the future.¹⁵

A researcher moves between the empirical world where data is gathered and the theoretical world in which theories and concepts are created or used. An *inductive approach* is used when the researcher collects facts and data about several cases and then uses them to build a general understanding or theory. The opposite, when a general theory is applied onto several empirical cases to reach a conclusion, is called a *deductive approach*.¹⁶

2.2 Research strategies

A research strategy is a general strategy chosen in accordance with the purpose of the study and does not include specific research methods¹⁷. The four most applicable research strategies for a master thesis within applied science are: surveys, case studies, experiments and action research¹⁸.

¹⁴ (Höst, et al., 2006, p. 29)

¹⁵ (Lekvall & Wahlbin, 2001, pp. 196-198)

¹⁶ (Arbnor & Bjerke, 2009, pp. 90-91)

¹⁷ (Denscombe, 2009, p. 26)

¹⁸ (Höst, et al., 2006, p. 30)

The survey approach is suitable when the study has a wide approach, mapping out the details of a subject. A survey strives to describe a phenomenon at a certain point in time, usually at the time when data is collected. The research is executed by conducting empirical data collection, either through literature studies but most often by collecting new data in the field. The most commonly used methods for data collection with this research strategy are described in section Data collection¹⁹. If a survey is conducted on a small population, the population as a whole can be used. If the population is large, a smaller sample can be selected to represent the whole population²⁰.

Case studies are in-depth studies of a presently existing phenomenon or object to find the cause of a problem or to understand a situation. Since the selection of the study object is not random, the findings can seldom be generalised, but sometimes the results can be applied on similar cases.²¹

Experiments are conducted in controlled environments allowing the researcher to adjust variables to see how they affect the phenomenon. An experiment is usually repeated with new variable settings. Experiments have a fix design; once the experiment has started the design cannot be changed.²²

Action research studies problems and situations which occur in the activities of everyday working life. It strives to involve the people studied in both planning and executing the study to make them feel comfortable, participate actively and be receptive to the findings. The study is cyclic; the first findings suggest changes which then are implemented and evaluated. If necessary a new study may be started to suggest even further improvements and this new study can build on the findings of the first one.²³

2.3 Data collection

When collecting data one needs to distinguish between primary and secondary information. Secondary information has been collected previously by other researchers and is usually gathered through literature studies. Primary information is collected by the researcher, often through; written questionnaires²⁴, direct observations, and/or interviews. Data can also be

¹⁹ (Denscombe, 2009, pp. 25-26)

²⁰ (Höst, et al., 2006, p. 31)

²¹ (Höst, et al., 2006, pp. 33-34)

²² (Höst, et al., 2006, pp. 36-38)

²³ (Denscombe, 2009, pp. 169-170)

²⁴ (Lekvall & Wahlbin, 2001, p. 261)

collected through experiments which are described in the previous section. When using secondary information its compatibility needs to be considered since the data might have been collected with another purpose or classified in a way not suitable to the new study. To which extent the data is correct is known as trustworthiness and also needs to be considered.²⁵

2.3.1 Written questionnaire

The most well-known type of surveys is the written questionnaire. These are usually sent to a large number of respondents by post, e-mail or posted on a website. The written questionnaire is seen as impersonal since it is sent without prior notice and since the questionnaire is the only mean of communication between the researcher and the respondent. The subject of the survey and the length of the questionnaire affect people's willingness to respond which is frequently low; resulting in a return rate around 20 %.²⁶

2.3.2 Direct observations

A direct observation is conducted by observing a present situation. Since data is only gathered during the observation, time and place affects the result and need to be chosen carefully. Observations can be conducted with low or high interaction between the observer and observant, also, the observant's knowledge of being observed can be either high or low.²⁷

2.3.3 Interviews

Interviews are used to collect data about complex situations and gain understanding of people's feelings, thoughts and experiences. They are also used when examining sensitive issues or subjects with privileged information. Interviews can be divided by their level of structure and the media used when they are carried out.

In structured interviews the questions, the order of the questions and the answering options are predetermined. All respondents follow the defined structure which makes a quantitative analysis a good option due to the standardised form of data.²⁸

In semi-structured interviews a list of questions and subjects intended to cover is used. Compared to a structured interview the interviewer is more

²⁵ (Arbnor & Bjerke, 2009, p. 180)

²⁶ (Denscombe, 2009, pp. 27-28)

²⁷ (Arbnor & Bjerke, 2009, p. 181)

²⁸ (Denscombe, 2009, pp. 233-234)

flexible about the order in which the subjects are covered. The interviewee is allowed to talk freely about the subjects he or she wants to, resulting in less structured, but more in-depth, data. When conducting an unstructured interview the interviewer introduces a subject and lets the interviewee talk freely for as long as he wants about the subject. The differences between semi-structured and unstructured interviews are small and sometimes the interview technique used is a combination of the two.²⁹

There are three ways of communicating with respondents when conducting interviews: personal interviews, telephone interviews or online interviews.³⁰

A personal interview has flexibility in the way the questions are asked and the answers recorded and are usually semi-structured or unstructured. Disadvantages are primarily high cost and time consumption. Telephone interviews can be described as a combination of written questionnaires and personal interviews. Computer aided support for telephone interviews has developed fast during recent years giving it more of the flexibility found in personal interviews. Telephone interviews are less time consuming and costly compared to personal interviews.³¹

Online interviews are usually conducted as written questionnaires. There are two main types and the difference between them has to do with how the respondents are chosen. If it is possible to find a sample big enough to represent the whole population and if all of them are believed to have internet access, the questionnaire can be distributed to them through email or posted on a website. The other way is to build a “panel” of people with certain criteria and interest to participate in a study. When the study is decided a sample is selected from the panel.³²

2.4 Sampling

When conducting research on a large population not everyone in the population can be included due to time and cost restraints. Instead a smaller group called a sample is selected. For larger populations a *random sample* is used and the belief is that this sample is representative for the total population so that the results can be generalised. When conducting in-depth studies on smaller populations a *subjective sample* can be used. This sample is

²⁹ (Denscombe, 2009, pp. 233-234)

³⁰ (Lekvall & Wahlbin, 2001, pp. 261-262)

³¹ (Lekvall & Wahlbin, 2001, pp. 265-267)

³² (Lekvall & Wahlbin, 2001, pp. 267-269)

not chosen due to its representativeness of the population, instead the people in the sample are believed to have knowledge or other insights of a subject which are useful for the study.³³

2.5 Qualitative and quantitative data

Data can be either qualitative or quantitative which affects both the gathering and analysis. Qualitative data is usually presented as words or pictures while quantitative data is presented numerically. Quantitative analysis is done by calculations or the use of statistics and qualitative analysis by reasoning presented as text or figures. Respectively data is generally analysed by the corresponding analysis. Qualitative data can also be analysed with a quantitative method e.g. calculating the number of times a word occurs in a paragraph. Quantitative data can also be analysed qualitatively e.g. reasoning about a company's result and balance sheet.³⁴

2.6 Credibility

When evaluating the credibility of a study three factors need to be considered; validity, reliability and representativeness³⁵.

Validity is a measurement of how the study's data collection measures what it intends to measure. One way to ensure the validity in written questions is to have them reviewed by a person with knowledge with in the field. The reviewer should immediately get a feeling whether the questions seem reasonable to measure the intended subject or not. This method is known as face validity³⁶. Another way to increase the validity of a study is to use triangulation by studying the object with more than one method³⁷.

Reliability measures the method's ability to withstand outer situational influences during the collection. If a data collection can be redone several times giving the same or at least similar result the reliability is considered high.³⁸

Representativeness concerns whether the results can be generalised. A survey or an experiment may only be generalised to the population from which the

³³ (Denscombe, 2009, pp. 32-33)

³⁴ (Lekvall & Wahlbin, 2001, p. 213)

³⁵ (Rosengren & Arvidson, 2002)

³⁶ (Lekvall & Wahlbin, 2001, p. 304)

³⁷ (Höst, et al., 2006, p. 42)

³⁸ (Lekvall & Wahlbin, 2001, p. 306)

sample was made. However, case studies or action researches are seldom considered generalised due to the subjective sample of object.³⁹

2.6.1 Achieving credibility

To ensure the validity in the interviews and the written questionnaire the questions were formulated to be clear and unbiased and they were reviewed by individuals with industry knowledge. After the interviews the result was shared with the interviewee to ensure he or she was not misinterpreted. Together with the clearly formulated questions this has ensure reliability in the interviews. To ensure overall credibility, multiple sources was used and examined critically throughout the data collection. When sources with conflicting views were found both views was used if they were believed to give a more balanced and holistic picture. Otherwise both sources were confronted when possible.

2.6.1.1 Triangulation

A common tool to achieve credibility in the findings is through triangulation, which means that the researcher use different sources when studying an object⁴⁰. When triangulating data, two different approaches are often used⁴¹:

- Informant triangulation is when the researcher use different kinds of data sources when studying the same object, for instance combining interviews and literature.
- Time triangulation is when the researcher use data which has been collected at different times.

Depending on the object, a combination of the approaches mentioned above may increase the credibility even further. Triangulation is often defined as “a combination of methods used to study the interrelated phenomena from multiple and different angles or perspectives”, thus if properly applied in a qualitative research approach, the validity of the research could be considered high.⁴²

2.7 Chosen method

Initially an exploratory approach was used to identify relevant theories to assess a geographic market for a WDRES, in particular wind power. The exploratory study revealed a gap in the theory, thus the CL²-model was

³⁹ (Höst, et al., 2006, p. 42)

⁴⁰ (Rothbauer, 2008)

⁴¹ (Denscombe, 2009, p. 186)

⁴² (Rothbauer, 2008)

created to fill this gap. The produced model was then applied in the second phase in which the key drivers in the market, the interaction between actors, and project process were identified and described with a combination of a descriptive and predictive approach. Finally an explanatory approach analysed the accumulated information of the market to explain the interaction of different factors as they laid ground to the concluding evaluation concerning the overall attractiveness of the market. An inductive approach was used as the study concerns *if the market is attractive to enter* rather than *how the market should be entered*.

The study covers a broad scope thus the research strategy used was a survey approach. At first secondary data was collected through literature studies to scan and evaluate theories and present a general overview of the Finnish wind power market. As the study proceeded, knowledge gaps were discovered in some areas. Thus, in-depth studies of these areas were conducted to create a complete picture of the market. These studies were primarily conducted through personal and telephone interviews with experts in respectively field. Both primary and secondary data was obtained as some respondents referred some material to other sources.

Subjective sampling was used to select the interviewees as the main subject of the interviews greatly varied due to the present gap of knowledge and the interviewees' core competencies. Both officials from several authorities together covering the whole planning and permitting process and wind developers were interviewed to triangulated information about the market from the two main perspectives, that off the authorities and that of the wind developers. As time was not a big constraint but costs were, personal interviews were preferred when not causing long and expensive trips. Four authority officials and two wind developers were interviewed in person and two wind developers by telephone. All interviews were semi-structured to ensure coverage of all topics needed to fill the information gaps and also to let the developers speak freely and in that way point out information that had not been considered beforehand. The interview questionnaire was validated beforehand through face validation with a wind developer. Information from the interviews that was referred to in the report has been sent to the respectively interviewee for them to control the interpretation. The final report has also been sent to many of the interviewees as they have been interested in the findings.

Several presentations given by authority officials and wind developers were attended during the Vaasa Wind Exchange conference in March 2014.

A written questionnaire was sent out to 52 actors on the Finnish wind power market, they were selected through subjective sampling and the majority were; consultants, wind developers and investors. The questionnaire was validated through face validation with a developer beforehand. Since many of the actors in the market are international and since both Finnish and Swedish are official languages in Finland, the questionnaire was available in Finnish, Swedish and English. 12 answers were received, giving a return rate of 23 %, slightly more than the expected rate.

Both qualitative and quantitative data was collected and used in the study as they complemented each other in the pursuit of creating a comprehensive picture of the market. The theoretical framework included several models in which different types of data were preferred. The quantitative data was analysed through quantitative methods and the qualitative through qualitative methods. To increase the validity of the study, triangulation was implemented thoroughly through the process, both by using primary and secondary information and by interviewing industry professionals with different perspectives. To ensure the validity of the produced model, the preliminary drafts were presented to professionals and master thesis students in the studied field. The discussions led to minor updates to the final model.

The quantitative method was validated by comparing the answers to answers from a model used in the industry with input data from a wind turbine in the market and data from a Finnish wind power project. The project consists of 12 turbines, which is an average size for installed capacity as well as the project pipeline.

2.7.1 Criticism of chosen method

The choice of using an exploratory method in the beginning of the study was suitable to gain a first overview of the market. The further in-depth study used both a descriptive and predictive approach, which was suitable as both the current and future market needed to be analysed.

The study has gathered information on the Finnish wind power market, as many market it is dynamic and continuously evolving. The explanatory findings describe the current market conditions and the predictive findings make qualified guesses and prognoses for the future. Thus if the study would

be repeated soon after it was finished the reliability would be high. The further into the future the study is repeated the less will the reliability be since the market conditions change as time goes by.

The qualitative analysis was based on the collected information but also on the experience, business aptitude and beliefs of the researcher thus decreasing the reliability of the study. To decrease this risk clear connections and references to the empirical chapter was made in the analysis.

The validity of the study has been insured by validation of interviewee questionnaires, written questionnaires and the CL²-square model beforehand through face validation.

It is in the nature of a WDRES-project that several factors affecting the projects profitability varies from site to site. Thus in order to be able to evaluate projects quantitatively, assumptions have to be made. Therefore the quantitative results should be seen as an indicator of the profitability instead of an absolute number. The reference project was selected as it represents an average of projects in the market to give an indication of the market as a whole. Projects with better and worse fundamental conditions existed in the market.

The developed model was tested by application to the Finnish wind power market which is a geographical market for one type of WDRES. The findings of this study are therefore not generalizable to all WDRES on all geographic markets. The chosen method was nevertheless considered the best alternative for validating the model giving time and other constraints of the study. The results of the study can be seen as an indicator of the models usability but further studies will have to show if it is applicable to other markets.

As the findings of the study were presented to industry professionals and academia the authors received valuable feedback that was used to further improve the study.

2.8 Research process

The research process was semi-structured over the time period when the study was produced with iterations between the phases, the process is visualised in figure 3.

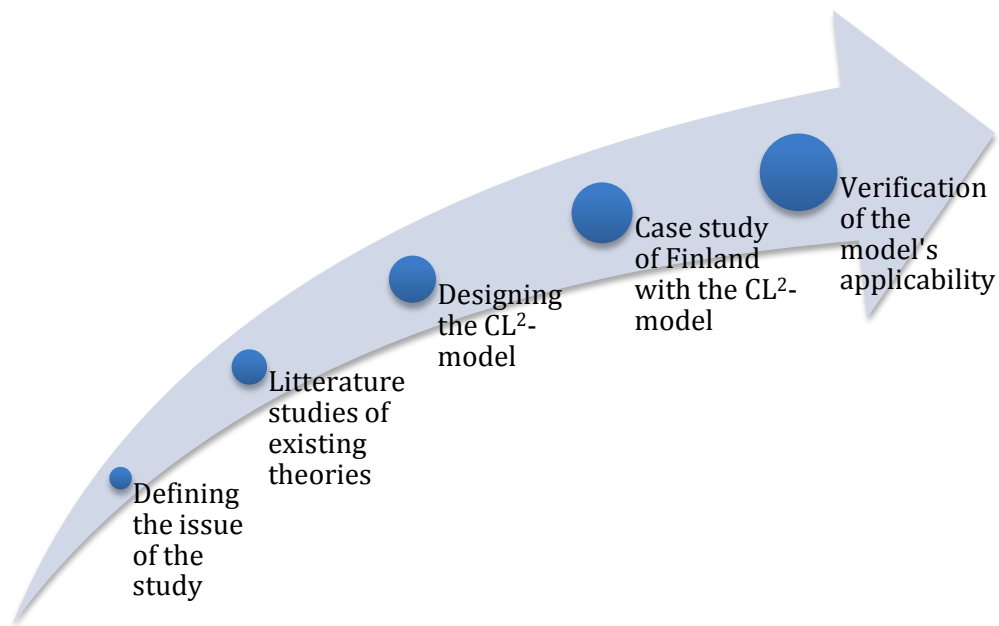


Figure 3: The research process

2.9 Source criticism

A variety of sources were used to cover many perspectives and build a comprehensive knowledge of the study object. Secondary information was collected from; books, reports, law texts and websites, as knowledge gaps were found they were filled by primary information from interviews. All sources were thoroughly examined and the original source has always been search for.

People in general have different experiences and perspectives depending on their background, believes and profession that is also the case in the wind industry. This was compensated for by the use of triangulation, by selecting interviewees through selective sampling from authorities and both Finnish and international wind developers. Information received from the primary data collection was used if it was verified by several respondents or could also be found in secondary sources.

3 Theoretical framework

To be recognized as a scientific study, the structure of the empirics and results must rest on a stable foundation of acknowledged theoretical framework. This chapter present relevant theories to be used as foundation in order to assess the objective of the study. The presented frameworks are later developed in chapter 4 were a new framework for the study is created.

3.1 Theoretical approach

To assess the attractiveness of investing in a geographical market for WDRES energy production several factors needed to be analysed. Such a market is highly politicised, regulated and also affected by the macro economy. These and other macro-factors are covered by the PESTEL framework. The framework was chosen to be used for mapping the macro-environment since it gives the most complete picture for the WDRES market.

When assessing the attractiveness of a geographical market one also needs to understand the actors and drivers in the national industry for the particular WDRES of interest. Porter's five forces is a model that gives a complete mapping of an industry with concern to its drivers, actors and how the profitability is divided. As it is widely used and covers the factors of interest to us it was chosen for the industry analysis.

Investing in renewable energy project is a long process. Understanding the tasks involved, the time frame and the risks requires a full understanding of the process. The project lifecycle model XLPM was chosen for this since it has sufficient number of phases and is generic enough to cover the process of investing in all types of WDRES projects.

Finally as for all types of industrial investments capital budgeting is also need for these types of energy projects. The NPV-model and the IRR-model, complementing each other and giving solid evaluations of investments with long time horizons were chosen for this. They were complemented by the energy industry specific calculations of levelised cost of energy.

3.2 Mapping the macro-environment⁴³

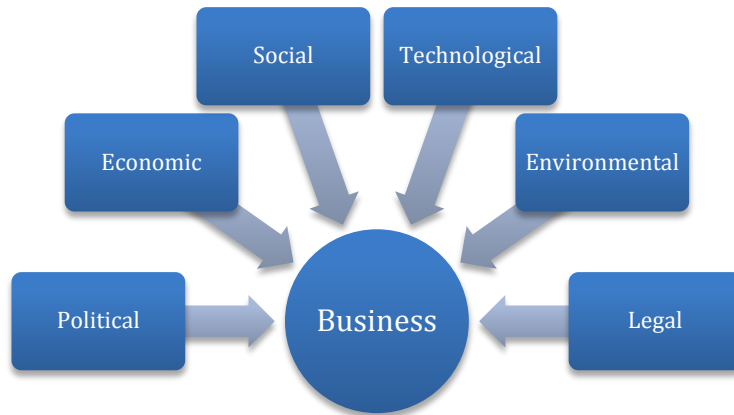


Figure 4: The PESTEL framework

The PESTEL framework is used to scan and describe the macro-environment. It stands for Political, Economic, Social, Technological, Environmental and Legal. At first the framework was introduced just as PEST, then legal was introduced and the letters rearranged to SLEPT. Later on environmental became a factor and the abbreviation PESTEL became a concept presented in most corporate strategy literature. Lately, two more factors has been introduced, Ethics and Demographic, and the framework called STEEPLED. This study will apply the PESTEL framework.

PESTEL identifies sub-factors that cause both opportunity and threat. It is often used to identify trends that particularly may impact the market, the so called **key drivers**. PESTEL is not a complete science, but is a useful tool to get a general idea of a market situation.

3.2.1 Political

The political situation is a critical factor when mapping a market, and it could concern multinational, national or even the local political climate. A stable political climate is often preferred, as instability may lead to for instance policy changes affecting current business situations and profits. Identifying political trends that would change the current situation could, if used correctly, turn out very beneficial and alter present competitive advantages. The time until the next election could turn out to be vital within some industries.

⁴³ (Johnson, et al., 2009; Mind Tools, 2014a; Communication 18 Ventures, 2014abcde)

Sub-factors to the overall political climate are for instance tax policies, tariffs and other subsidies, trade restrictions and policies on state regulation/deregulation. Bureaucracy and the timeframe for processing authorization to initiate operations on the market are also of concern.

3.2.2 Economic

The economic climate depends on a number of factors such as economic growth, interest rates and exchange rates. A region which experience stagnated growth and bad future outlook is often less favourable due to the increased risks of doing business there. Some industries are dependent of access to capital and the cost of capital, which also could be a deal breaker. However, the financial system is highly globalized which at least should lead to reasonable access to capital.

The labour market is another important aspect. A rising unemployment rate combined with decreasing disposable income of the consumers indicates less favourable economic conditions. Depending on the needed skill of the labour force, opportunities may arise. A large labour supply and need for low-skilled workers may imply low labour costs as opposed to a low-skilled labour supply when high-skilled labour is needed.

3.2.3 Social

Social aspects of a region may include demographics, religion, age distribution and the overall culture. The way of doing business varies greatly depending on the underlying culture. Mapping the social factors helps to understand the market and customers. The attitude towards change differs between regions thus new products may be accepted on some market whereas some markets may refuse them completely. However, these *softer* aspects are often difficult to quantitatively measure even though they impact the business potential greatly.

3.2.4 Technological

A significant uncertainty concerns the emergence of new technologies with potential to impact the business. It could be brand new technology developed by for instance university or research institutes, but it could also be technology transfers to more rural regions where the level of technology has been low. High-tech regions are often more adaptive to the newest technology, but the actual impact of a new technology may be greater when a simpler, but more “useful”, product is introduced on a low-tech market. The different needs in different regions may also affect the use of a certain technology – such as

the widespread use of mobile payments in Africa while this method is less common in the more industrialised countries of the world.

3.2.5 Environment

The importance of environmental issues has increased over the last decades creating new vital aspects that must be considered when conducting business. There is a slight negative correlation between environmental and economic factors as being environmental friendly often incurs increased costs. The raised awareness of global warming and corporate social responsibility has pushed companies to adapt their footprint and conform to the new standards set by society.

3.2.6 Legal

The legal systems may vary a lot between regions and present certain advantages or disadvantages for businesses. Labour laws and consumer laws are of importance for companies' ability to perform business in different regions, some countries are less restricted concerning for instance the rights of the labour force. Another factor regards the level of how the legal system is upheld or if it is easily corrupted.

3.3 Analysing the industry⁴⁴

To people in general as well as to managers and strategists, competition is what appears between two companies selling the same products on the same market. This is a narrow idea of competition correctly defined as direct competition. An industry's profitability is effected not only by direct competition but by several actors; customers, suppliers, potential entrants, and substitute products. These actors impact an industry's competitiveness and are described in *The five competitive forces that shape industry competition* more commonly known as "Porter's five forces" after its originator the Harvard Business School professor Michael E. Porter.

Industries are very different from one another. The global auto industry and the heavily regulated European health care delivery industry do not seem to have much in common when looking at them at a glance. But their underlying competitive forces and attractiveness can both be analysed with the competitive forces.

When the forces are strong as they are in the airline, hotel and textile industries hardly any company is profitable. When the forces are favourable

⁴⁴ (Porter, 2008; Porter, 1998)

as they are in software, soft drinks and toiletries many companies earn an attractive return on investment. As seen in the previous examples, both emerging and mature, high tech and low tech industries, products and services can be profitable depending on their structure and dominant competitive forces. In the short run many factors can affect an industries attractiveness, for example the weather and the business cycle. But in the medium and long run the competitiveness is driven by the competitive forces.

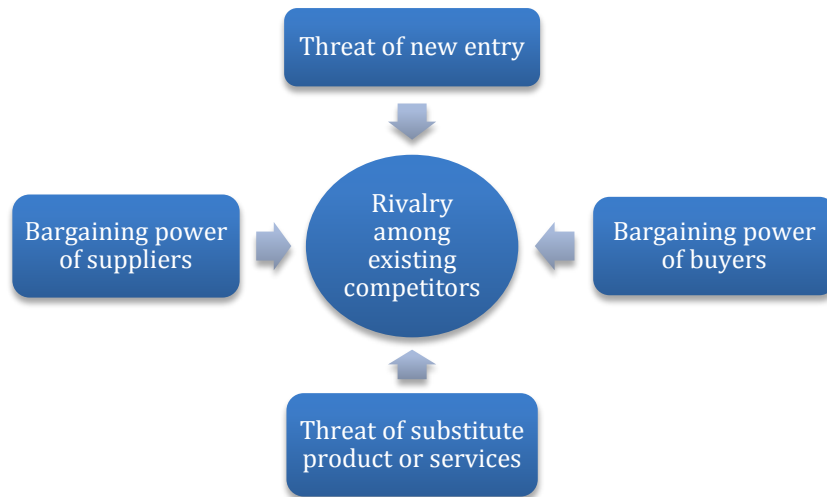


Figure 5: Porter's five forces model⁴⁵

3.3.1 Threat of new entrants

New entrants bring more capacity to the market and try to gain market shares which put pressure on prices and costs and increase the need for investments. Companies entering from related markets can use their existing cash flows and competences and raise the level of competition. The threat of new entrants depends on how hard the entry barriers are to overcome and what reactions a new entrant expects from the incumbents. Since the threat of intruders, forces companies to invest and keep competitive prices, it is the threat of and not the actual new entrants that are the force.

3.3.1.1 Entry barriers:

1. *Supply side economies of scales* – occurs in industries with large fixed cost where a large production gives economies of scales and decreases the unit price. An entry needs to be large scale or the entrant will have to accept a cost disadvantage.

⁴⁵ (Porter, 1998)

2. *Demand side benefits of scales* – these benefits arise when customers are more likely to use a service when many other customers do. This is also known as network effects and an example is that many people use eBay since they know that many others do which increase the reach to potential customers.
3. *Customer switching costs* – the fixed cost that a customer needs to pay when switching from one supplier to another. These costs arise if the customers have to change product specifications, retrain its employees or redesign its business processes.
4. *Capital requirements* – the need to invest large amounts of capital in start-up cost such as facilities or inventory to be able to compete. The barrier grows higher for irrecoverable investments such as, advertising or research and development. The importance of capital requirements as a sole barrier should not be overstated. If an industry has large capital requirements but shows a potential for long-term profitability and the capital markets are well functioning there should be investors willing to supply capital for an entrant.
5. *Incumbency advantages independent of size* – no matter their size existing actors have advantages that are not available to entrants. They can come from various sources such as brand identity, stores in the best location or efficient production as a result of long experience and development.
6. *Unequal access to distribution channels* – new entrants must gain access to existing distribution channels or create new ones. A new food product must compete with existing ones over the shelf space in supermarkets through lower prices or promotions. The low cost airlines choose to skip the old way of distributing through travel agencies and started selling their tickets on their own websites instead.
7. *Restrictive government policies* – governmental policies can increase entry barriers through regulation of industries such as liquor retailing, environmental or safety regulations that increase the need of economies of scales or by hard patenting regulations making it harder to imitate existing technologies. On the other hand a government can

also decrease the entry barriers through subsidies or by funding research and making the results publicly available.

In addition to the entry barriers the expected reactions from existing actors in the market can also scare off new entrants. If incumbents previously have protect their markets from new entrants decisively and shown this publicly that will scare off new entrants. The attractiveness for new entrants also decreases if the existing actors have important resources such as financial resources, access to productive capacity or close ties to the distribution channel. If the market growth is low new entrants will have to take market shares from the incumbents to grow and can therefore expect big retaliations. If the industry has big fixed costs and excess capacity the existing players are likely to cut prices to fill their capacity pressuring the profitability for new entrants.

3.3.2 The power of suppliers

Powerful suppliers can influence an industry by raising prices, decreasing quality of products or services or shifting cost upwards in the value chain. If companies in the industry cannot shift their raising cost over to their customers by raising prices this decreases the profitability of the industry.

The following industry conditions increase the power of suppliers: When an industry is dominated by a few large suppliers selling to many smaller buyers. The industry is not an important customer to the supplier. If the industry only makes up a small fraction of the suppliers sales they will get less attention and worse terms. When the supplier's product is of strategic importance for the buyer and it is hard for the buyer to build a stock of the product. If there is a switching cost for the buyer when changing supplier. The supplier is a seriously potential entrant to the industry through forward integration. The lack of substitute products decreases the competition and the possibility to balance power for smaller buyers.

Another form of supply is that of labour. In industries where there is a shortage of highly skilled and strategic important professionals or if the labour is highly unionized the power of labour is high.

3.3.3 The power of buyers

Powerful buyers influence an industry by demanding low prices, higher quality in products or services and try to get this by playing the competitors against each other, all these action decrease the industry profitability.

The following industry conditions increase the power of buyers: The number of buyers is low or a single buyer accounts for a large fraction of the total sales of a supplier. This is especially true in industries with large fixed costs. If the industry accounts for a large share of the buyers overall procurement they are willing to spend money and time to shop for good prices and terms. Standard or undifferentiated products make it easier for buyers to switch supplier and have suppliers compete for ones business on price. The supplier switching cost is low. Low profitability gives high incentives for lowering purchasing costs. Buyers with the knowledge of doing things in-house know the cost of production, leveraging price negotiations. They are also a credible threat of expanding into the suppliers business by backward integration. The quality of the buyers' product is not affected by the quality of the industry's product. The market price, the cost of production and demand is known to the buyer.

3.3.4 Threats from substitutes

Substitutes are products from other industries providing the same or similar function and therefore competing for the same customers. The definition seems clear but finding all of one industry's substitutes can be a challenging task. When shopping for a father's day gift, a tie and a power drill are considered as substitutes. A substitute for buying a new product is to buy a used one, not buy one at all or to do it or produce it in-house instead. Substitutes have low switching costs and they limit industries profitability and often growth potential.

Customers compare price-performance ratios for substitutes form different industries limiting these industries profitability. Collective industry investments in marketing, quality improvements and availability can decrease the power of substitutes.

The most dangerous substitutes are those with an improving price-performance ratio compare to that of the industry and those in highly profitable industries. The second one is likely to look for new business opportunities if their profit margins are decreased by increasing competition. A company's strategy needs to be adapted to its substitutes, either by fighting them or when that is not possible planning for adapting to their existence.

3.3.5 Rivalry among existing competitors

Price discounts, product introductions and advertising campaigns are forms of rivalry among existing competitors. Competitors within the same industry are interdependent, if one of them takes action it will affect the others which are

likely to retaliate. Many times this puts a squeeze on the industry's profitability and leaves everyone worse off. The degree to which this happens depends on the intensity of the rivalry and its basis.

Circumstances increasing the intensity of rivalry: There are many competitors with the same size. There is no industry leader pushing through standards or practices needed for the whole industry. Slow market growth. Specialized resources or management commitment cause high exit barriers and keeps unprofitable firms in the industry and provides excess capacity, decreasing the overall profitability.

The most unprofitable form of rivalry is that of price competition. When one actor starts lowering its prices others will have to follow, customers gets used to lower prices and there focus shifts from quality and services to solely price. Price competition is more likely to happen in the following situations. When products and service are very similar and there are small switching costs for customers. In industries with excess capacity where marginal costs are low and fixed costs are high, forcing companies to decrease their prices towards their marginal cost to gain a few new customers and earn some money to cover their fixed costs. In industries where large investments are needed and this creates large increases in capacity. In industries where the products are unperishable and needs to be sold before it loses its value.

Competition by other offerings than price such as – brand image, product features, service and delivery time – will usually increase the industries overall attractiveness and improve its position against substitute industries and hence increase the overall profitability.

Even though price competition many times lead to an overall decrease in profitability it does not have to. If competitors divide the market into customers segments with varying prices and features and compete for their own segments they do not have to compete head to head. They can even expand the market by attracting new customers and thus improve the profitability.

3.4 Strategic decision making⁴⁶

A SWOT-analysis is a common tool to use when making strategic decisions. It evaluates the *strengths*, *weaknesses*, *opportunities* and *threats* of a project or business venture by identifying internal and external factors that are most

⁴⁶ (Johnson, et al., 2009, pp. 81-83; Mind Tools, 2014b)

likely to affect the strategic development. The SWOT is often illustrated by a 2×2 matrix such as the one in figure 6 below.

	Helpful to achieving the objective	Harmful to achieving the objective
Internal origin (attributes of the organization)	Strengths	Weaknesses
External origin (attributes of the environment)	Opportunities	Threats

Figure 6: The SWOT matrix⁴⁷

The SWOT-analysis categories key factors of information into the two horizontal rows in figure 6 above:

- Internal factors: the strengths and weaknesses within the organization
- External factors: the opportunities and threats existing outside the organization.

External factors are i.e. political and economic that could impact the approach to achieve the organisation's objective(s). These factors are often identified using the PESTEL framework described in section 3.2.

The SWOT should not be applied in absolute terms but in relation to competitors – a factor considered as strength could in relation to other competitors essentially turn out to be more of a necessity. It can be applied not only on organizations, but also on industries, geographic locations or individuals.

⁴⁷ (How-to-start-a-business-guide.com, 2009)

3.4.1 Criticism

Johnson et al (2009) briefly mentions two dangers of the SWOT, namely the possibility of excessive quantities of factors yet no indications of their respective importance and the risk of overgeneralization as the underlying reasons of the generated factors remains unexplained. Other studies have investigated the pitfalls of SWOT further and one of them stated the concerns in the bullet list below⁴⁸:

- *"The length of the list.*
- *No requirement to prioritize or weight the factors identified.*
- *Unclear and ambiguous words and phrases.*
- *No resolution of conflicts.*
- *No obligation to verify statements and opinions with data or analyses.*
- *Single level of analysis is all that is required.*
- *No logical link with an implementation phase."*

Hence, this study will be careful when applying SWOT and attempt to adjust it to today's dynamic marketplace.

3.5 Project life cycle⁴⁹

It is common practice today to use a project life cycle model (PLCM) to plan and manage projects, especially in large organisations. It is an efficient method to make structured and well-informed decision throughout a project which may deal with a great number of uncertainties. A widely used model is PROPS which was developed and is owned by the Swedish ICT-company Ericsson. The method is now being administered by Semcon, who has developed a new generation of PROPS for external parties under the name XLPM (Excellence in Project Management)⁵⁰. This model is general and used in all types of companies and organisations.

3.5.1 XLPM

XLPM is a methodology to manage projects, programs and project portfolios in a project-based organisation. Its purpose is to support successful management of project-based activities within an organisation and contribute to the organisations long-term business objectives. The methodology to manage projects is illustrated by the PLCM in figure 7 below.

⁴⁸ (Hill & Westbrook, 1997)

⁴⁹ (Semcon, 2014)

⁵⁰ (Semcon, 2011)

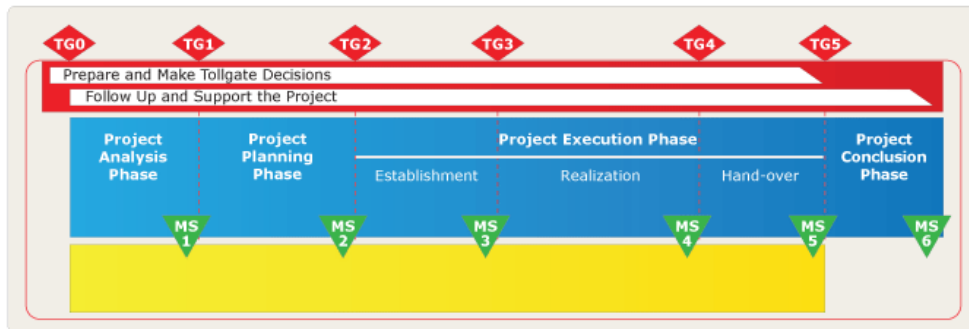


Figure 7: XLPM's project life cycle model⁵¹

The model covers all activities, decisions, documentation, and processes needed in a project to ensure its eventual success. The project life cycle is divided into four main phases and three parallel areas of responsibility.

- The project steering function is responsible for the steering process and the business decisions (called tollgates).
- The project management function is in charge of the project management processes.
- The project execution function is responsible for accomplishing all activities for a successful implementation according to the project specifications.

3.5.2 Project steering process

It describes all activities and business decisions that the project steering function is responsible of. It is the only process which covers the entire lifetime of a project and one of its main components are the tollgate decisions.

3.5.2.1 Tollgates

A tollgate (TG) is a formal and in advance defined decision point where decisions concerning resource allocation and the goal of the project are made. At each tollgate the business case is valued and assessed in regards to the risks implicated in the project. This assessment serves as the foundation when deciding how and under what conditions to allocate resources for the next phase. The tollgates are generic and should be applied in all projects.

- *TG0: Decision to start project analysis (is considered optional)*
- *TG1: Decision to start project planning*

⁵¹ (Semcon, 2014)

- *TG2: Decision to establish the project and start project execution*
- *TG3: Decision to continue execution according to original or revised plan*
- *TG4: Decision to hand over project outcome to internal receiver and external customer (if applicable)*
- *TG5: Project outcome accepted, decision to start project conclusion*⁵²

3.5.2.1.1 Tollgate decision

The final decision maker is the project owner whom before taking the decision must evaluate the business risks and opportunities. The standardised decisions to make are:

1. Continue according to the current plan.
2. Change the scope or conditions of the project, thus a new tollgate decision will have to be made once new information is presented.
3. Discontinue the project.

The decision making process in the XLPM methodology is illustrated in figure 8 below.

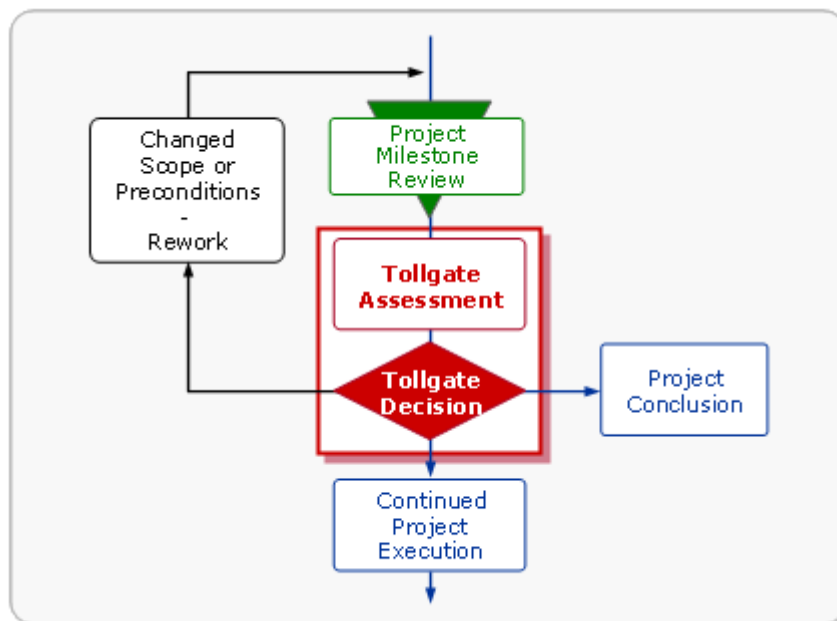


Figure 8: XLPM's tollgate decision making process⁵³

⁵² (Semcon, 2014)

⁵³ IBID

3.5.3 Project management process

The project management process is divided into four different phases by the tollgates because of the decision making concerning financing and uncertainties at these times. However, the phases are not directly related to specific activities in the work process.

3.5.3.1 Project Analysis Phase

The TG0 decision is followed by the project analysis phase in which the project idea is assessed from a commercial and feasible perspective. In this phase essential stakeholders are identified while initial requirements and the expected outcome are defined.

3.5.3.2 Project Planning Phase

The scope, goal and organization are defined during the planning process as well as the opportunity vs. risk assessment. During this phase a cost estimate and timeframe of the project is developed and all these factors are accumulated in a project specification which serves as a foundation for the TG2 decision.

3.5.3.3 Project Execution Phase

The project execution phase is divided up in three sub phases: establishment, realization and hand-over.

3.5.3.3.1 Establishment

According to the project specification the project organization is staffed within all three functions defined in section 3.5.1. Meanwhile the budget and timeframe is confirmed to lay ground for the next sub-phase.

3.5.3.3.2 Realisation

The project carries on based on the plans and conditions decided in TG3. The management in this phase is much about coordinating within the internal organisation as well as with external stakeholders. It is during the realisation phase that the project outcome is finalised and integrated.

3.5.3.3.3 Hand-over

In this process it is important to ensure that the recipients are acknowledging the hand-over and accepting the project outcome.

3.5.3.4 Project Conclusion Phase

By this time most project members have left the project in the hand-over phase and returned to their regular positions in the organisation. It is

important to make sure that the project has been well documented and that the organisation can learn from the experiences. The project manager should be in charge of this task but in the end it is up to the organisation to make sure all experiences are being exploited in future projects. All processes in the project are closed down in this phase.

3.5.4 Project Work Model

The generic XLPM PLCM work model seen in figure 7 has no general activities like the steering and management process. The work model considers all operative processes in the project and how to structure them to create a full picture of the project. The work model should define what work processes, methods and tools that will be used during the project.

3.5.4.1 Milestones

Milestones are a way to structure the timeframe of the project and represent a result being met at a certain point in the project process. There is no direct correlation between a tollgate and a milestone as the tollgate decision is based on the assessed business case while the milestone is a result reached in the process. It is however recommended to have a tollgate being preceded by a milestone as it often has concrete and valuable information concerning the status of the project.

3.6 Investment capital budgeting

Investment capital budgeting is the process of assessing the economic benefits and costs of a potential investment over its life time. The purpose can be to see if an investment will be profitable and if it will reach a predetermined profitability level or to compare several possible investments.⁵⁴

3.6.1 The time value of money⁵⁵

According to the time value of money in normally functioning economies a euro today is worth more than a Euro tomorrow. This is due to two reasons. Firstly, a Euro today can be invested in for example a bank account paying an interest of 5 % making it worth 1.05 Euros a year from today. Secondly, in normally functioning economies prices rise and cause inflation. The inflation target of Sweden is 2 %⁵⁶, when the inflation is at that level prices rise 2 % annually. 1 Euro today that is not invested will be worth 1 Euro in a year from

⁵⁴ (Berk & DeMarzo, 2011)

⁵⁵ IBID

⁵⁶ (Sveriges Riksbank, 2011)

now but the prices will on average have risen with 2 % making the real value of the 1 Euro 2 % less.

Investment capital budgeting uses cash flow to assess the economic benefits and cost of an investment. Cash flows are positive when a payment is received and negative when payments are made. Due to the time value of money, all the cash flows of an investment need to be moved to the same point in time in order to calculate the total cash flow.

3.6.2 Net present value - NPV⁵⁷

As previously stated to compare the cash flows of an investment one needs to move all the cash flows to the same point in time, in practice this point is usual the present and the value is called the present value. When subtracting the present values of all the benefits with all the cost we get the net present value, NPV. To correctly calculate the NPV it is crucial that all future positive and negative cash flows are known.

$$NPV = PV (Benefits) - PV(Costs)$$

The NPV calculation is widely used as a financial decision basis in the world. If an investment has a positive NPV it should be made and if the NPV is negative it should be rejected. When comparing investment alternatives, the one with the highest NPV should be chosen.

To move money back in time is known as discounting and is done by dividing the amount of Euros with a discount rate. It can be the current bank rate known as the risk free rate or an internal rate set by the company making the investment. Combining the NPV formula above with the discount rate and inflation gives us the following formula for calculating the NPV:

$$NPV = \sum_{n=0}^N \frac{CB_n * (1 + i)^n}{(1 + r)^n} - \sum_{n=0}^N \frac{CC_n * (1 + i)^n}{(1 + r)^n}$$

NPV = Net present value, N= number of years of the investment, n= each year of the investment from 0 to N, CB=cash flow of benefits, CC = cash flow of costs, r= discount rate, i=inflation.

⁵⁷ (Berk & DeMarzo, 2011)

3.6.3 Internal rate of return- IRR⁵⁸

Another frequently used decision basis for investment decision is the IRR, which is related to the NPV. The IRR is used when the NPV and cash flows are known but the discount rate is not. It is defined as the interest rate that sets the NPV of the cash flows to zero. When facing an investment with a negative cash flow today and a positive at some point in the future, the IRR can be calculate to give the annual rate of return that the investment could have been invested at to give the same future positive cash flow. If the IRR of an investment is higher than the rate of return the investor expects from investments the investment will be made, otherwise it will be abandoned. Shown below is the general formula for IRR calculation with future cash flows of various sizes.

$$NPV = \sum_{n=0}^N \frac{C_n}{(1 + IRR)^n} = 0$$

NPV= Net present value, N= number of years of the investment, n= each year of the investment from 0 to N, C= total annual cash flow, IRR=internal rate of return.

3.6.4 Combining NPV and IRR

Calculating the NPV with a certain discount rate and calculating the IRR and comparing it to the same discount rate is based on the same mathematic and should therefore give the same conclusion on whether to make an investment or not. When comparing two investments with different time horizons this might not be true. The NPV can be higher for the longer investment requiring a bigger initial investment and the IRR can be higher for the shorter investment. Some claim that the shorter investment is more attractive since it will generate cash flows faster and these can be reinvested at the higher IRR. This is a theoretically assumption used in the IRR model but in reality there is competition for attractive investment resulting in convergence of high IRRs to the return rate levels required by companies.⁵⁹

A solution to this is the modified IRR (MIRR), the discount rate for which a projects NPV equals zero after all the cash flows have been moved to the terminal point by use of the required rate of return. The MIRR builds on the idea that the cash flows generated by an investment can be reinvested at the

⁵⁸ (Vernimmen, 2006)

⁵⁹ IBID

required rate of return and therefore gives a more realistic result.⁶⁰ When calculated on investment alternatives with different time horizons the MIRR should give the same investment recommendation as the NPV.⁶¹

3.6.5 Levelised cost of energy – LCOE⁶²

LCOE calculates the cost of producing one unit of energy, for example 1 kWh of electricity. It is used to compare investments in alternative energy production or to compare the cost of production per MWh with the estimated income per MWh. The LCOE is calculated by summing the cash flows of all costs discounted to present time and then dividing it with the total estimated energy production.

$$LCOE = \frac{\sum_{n=1}^N \frac{(I_n + M_n + F_n) * (1 + i_n)^n}{(1 + r)^n}}{\sum_{n=1}^N \frac{E_n}{(1 + r)^n}}$$

where,

I_n = Investment expenditures year n

M_n = O&M expenditures year n

F_n = Fuel expenditures year n

E_n = Electricity generation year n

r = discount rate

N = Life of the system

3.6.6 Weighted Average Cost of Capital – WACC⁶³

The WACC, the average cost of capital for a company is determined by the capital structure, the percentage of debt and equity of the total capital and the interest rate to be paid on the debt and the expected rate of return from the owners on the equity. It is a risk-adjusted interest rate and since it is the cost of capital for a company it is commonly used as a discount rate when evaluating potential investments.

$$WACC = (C_d * W_d) + (C_e * W_e)$$

C_d = cost of debt, the interest rate paid on debt, W_d = percentage of debt in the capital structure at market value, C_e = cost of equity, the rate of return that the

⁶⁰ (Bingham & Houston, 2009)

⁶¹ (Vernimmen, 2006)

⁶² (Manwell, et al., 2009; IEA Wind, 2011; Wikipedia, 2014)

⁶³ (Pratt & Grabowski, 2010)

owners expect, W_e = percentage of equity in the capital structure at market value.

3.7 Wind power theory

Wind is air in motion, and since air has a mass, wind contains kinetic energy. The wind power P_{kin} [W] passing through an area A [m²] is determined by the following formula:

$$P_{kin} = \frac{1}{2} \rho A v^3$$

Where ρ [kg/m³] is the density of air and v [m/s] is the air velocity. As seen in the formula, the power is proportional to the third power of the air velocity, thus a minor difference in the air velocity alters the power considerably more. This states that the wind conditions are essential when exploring sites for wind farms.⁶⁴

Two different locations may have the same mean wind speed (determined over an appropriate timeframe) but the conditions of the sites may yet differ due to frequency and duration of different wind speeds. Research has shown that the observed data at a location often fit the Weibull probability distribution. Thus it is imperative to perform sensitive measuring of the location to estimate the potential of the site.⁶⁵

3.7.1 Energy conversion

The conversion from wind energy to electrical energy takes place in the rotor and generator of the wind turbine. However, it is not possible to utilize all the energy in the wind as that theoretically would mean that the wind speed would be zero after passing the turbine, blocking any more wind to pass through. The utilization of the wind energy is called the power coefficient and denoted C_p . Inserting C_p in the formula from the previous section gives the power that a turbine can generate:

$$P_{kin} = \frac{1}{2} \rho A v^3 C_p$$

Albert Betz from Germany was the first to show that the most efficient turbine would reduce the wind speed by 1/3 going through the turbine and another 1/3 after passing the turbine. Furthermore, the theoretical maximum of the

⁶⁴ (Wizelius, 2002)

⁶⁵ (Manwell, et al., 2009)

wind to be utilized by the turbine is determined by Betz law and relates to $C_{p_{max}} = 16/27$ ($\approx 0,593$). In reality $C_p < C_{p_{max}}$ because of aerodynamic and mechanical friction losses.⁶⁶

3.7.2 Turbulence

Turbulence occurs when wind encounters obstacles. As it tries to pass the obstacle air vortices and waves are created and the wind starts moving in different directions around the main wind direction. Turbulence can also be the cause of temperature differences in the air. So when the wind passes a rotor heavy turbulence is created which poses a problem, especially in wind farms. The turbulence generally affects the wind over a distance of circa 10 rotor diameters. The effects on the wind turbine when exposed to turbulence could be damaging, thus the turbines have to be solidly built. Building the turbines too closely does not give the turbulence time to wear out which constrains both the power output and the life expectancy of the delicate parts of the generator.⁶⁷

⁶⁶ (Wizelius, 2002)

⁶⁷ (Manwell, et al., 2009)

4 Model

This chapter presents the developed CL²-model which is applied on the wind power market in Finland in the following chapters. The model is divided into two parts, a more qualitative market assessment part and a detailed breakdown of the project process in order to construct a WDRES.

The theories presented in chapter 3 are generic and to be used on many different markets and within many industries. Thus they are not detailed enough and not adaptable to the specific conditions of the WDRES markets, for which; the political influence and control both on a national and international level, the complexity of the energy market and mapping the life-cycle are the biggest. Both a qualitative and a quantitative evaluation were found needed and no model including both as well as being applicable to the WDRES-markets were found.

By using the theories from chapter 3 as a basis to build upon and in accordance with the definition of WDRES and the delimitations defined in the introduction and, a new theoretical framework, the CL²-model was developed. The authors have had other master thesis students and professionals within the area of expertise validate the model which is illustrated as in figure 9 below.

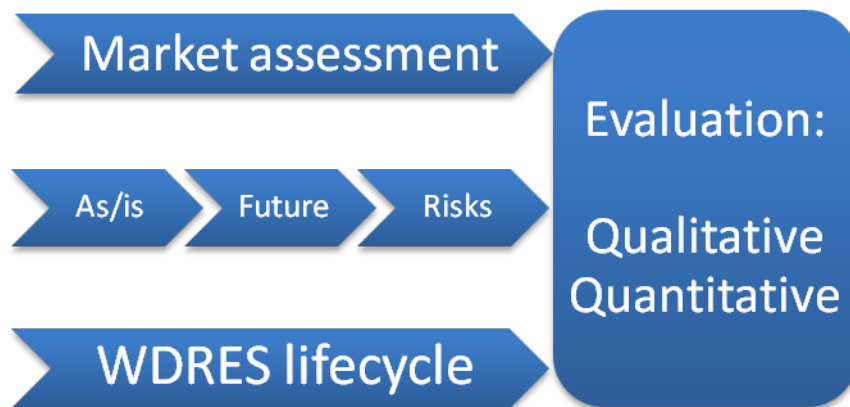


Figure 9: The CL²-model

As shown in figure 9 above, the CL²-model focuses on two different categories to establish the market attractiveness: the market assessment and the lifecycle of the WDRES. These two categories are assessed in three different steps.

1. As/is: First, the current state of the category is explored to map how the market looks today.
2. Future: Secondly, what does the future look like? It is imperative to consider both short-term and long-term factors.
3. Risks: All investments deal with risk so it is important to map all kinds of risks involved in the project. There are continuous risks during the permit process, as well as risks concerning the overall market picture such as political or macro-economic risks.

The MA (Market Assessment) category is primarily based on PESTEL and Porter's five forces while a literature study and interviews have been performed in order to map the activities, stakeholders and financial data that are involved for a WDRES and then applied these to the XLPM model.

4.1 Market assessment

The market assessment part of the model is divided into four main areas and these four areas are connected to each other, mainly top-down. It is based on a combination of PESTEL and five forces where the most essential factors have been used. The sub-model is shown in figure 10 below.

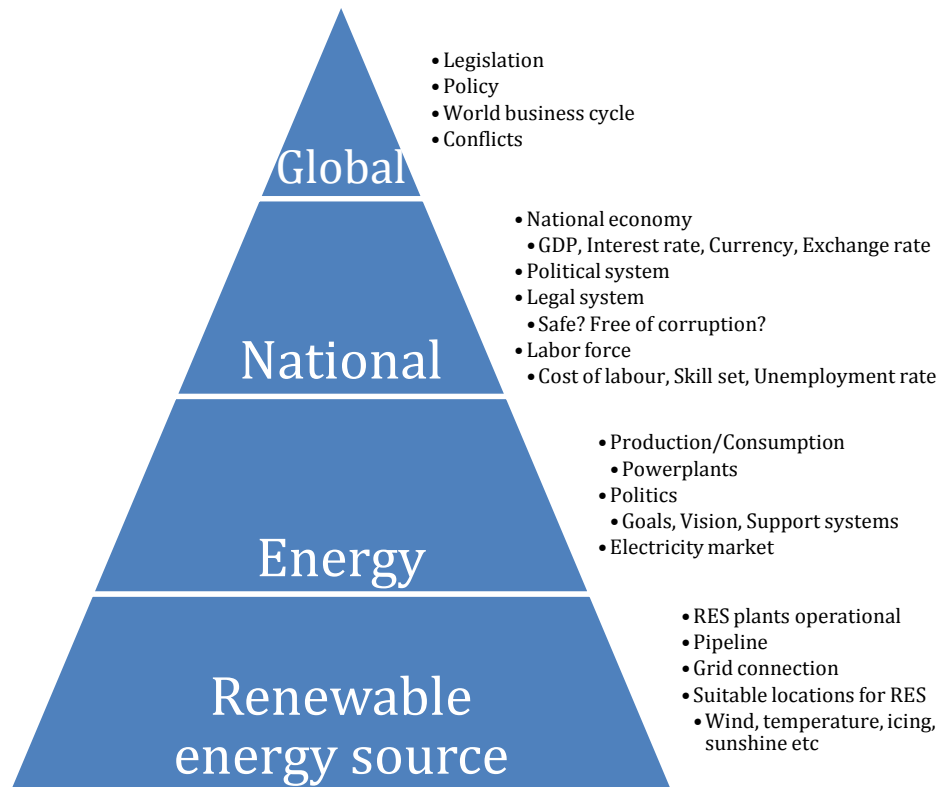


Figure 10: The MA pyramid

The purpose of illustrating the MA as a pyramid is explained by the way the areas are connected and the recommended time to explore the areas. When assessing a new market, it is recommended to initially spend small resources to identify factors on the macro-level that affects the market, for instance the Kyoto protocol and other transnational agreements that potentially affect the WDRES.

Secondly, what factors are affecting the nation which is being investigated? These factors are mainly connected to the national economy such as interest rates or taxes. When identified the most important factors, the national energy market should be investigated thoroughly. What production and consumption patterns are visible or what political goals and support systems are available?

Lastly, the market for the chosen WDRES should be clearly investigated around these factors:

- What plants are operational today?

- What is the status of the project pipeline?
- Where are suitable locations to construct a plant?
- Who are the main actors on the market, both in operation and pipeline?

4.2 WDRES Lifecycle⁶⁸

The WDRES lifecycle part is built around the XLPM project life cycle model with the approval of the owner Semcon. In addition to the model, a phase of generation was added to modify the project life cycle model to a complete lifecycle model in order to assess the entire life cycle of the WDRES investment. The life cycle model presented in figure 11 below describes the as/is-step in the main model into three subcategories: the main activities, stakeholder and financials. Since especially the permit process may differ depending on the country and/or WDRES it is important for the user to use this part as a framework as it is only a generalisation. As funding of the project is beyond the scope of this study this essential factor is disregarded below. The described factors were generated through a literature study and through discussions with both developers and authorities, and as the study's scope considers a developers point of view, the developer is withheld from the framework as it is included in every phase.

⁶⁸ (Ministry of the environment, 2012; O2, 2013a; EOLE-RES, 2014)

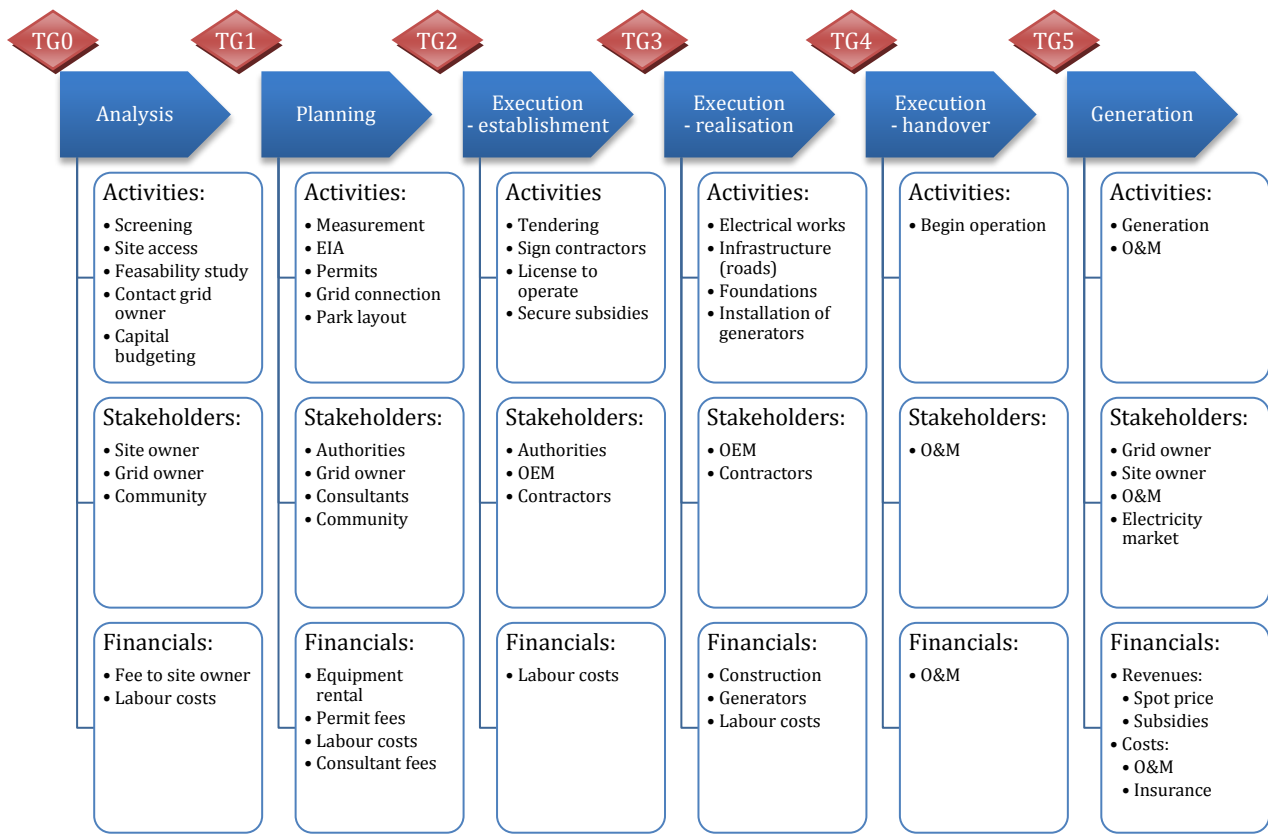


Figure 11: The life cycle of a WDRES

4.2.1 Analysis⁶⁹

The analysis phase is preceded by a TG0 decision to start analysing the feasibility of a project. The timeframe of this phase is 6-12 months.

4.2.1.1 Activities

The initial activity is to start screening for possible sites to construct a plant. When a possible site has been located, the developer should approach the land owner to secure the site. The developer could for example buy the property, but it is more common to lease the land. To secure access, a contract that states that the developer has exclusivity to the land should be used.

When a possible site is found a feasibility study is performed that amongst other factors focuses on these factors:

- Natural resources potential

⁶⁹ (Seabased, 2013a)

- Protection areas
- Grid connection possibilities

Then make the first draft concerning the technological aspects of the project like:

- Number of generators
- Generator position
- Total effect

In this phase the developer should contact the regional grid owner to clarify if it is feasible to construct a plant at the chosen site. Grid connections are often an expensive factor that needs to be considered. With the above mentioned activities, the developer should have enough data to create a rough investment appraisal based on estimates.

4.2.1.2 Stakeholders

The key stakeholders in this phase are the owner of the land where a site has been discovered and possibly neighbouring land owners that may be directly affected by a plant. Also, the regional grid owner is an actor to be considered.

4.2.1.3 Cost/revenue

This phase may incur costs as to fees to the site owner. It is not uncommon that contracts with option is signed, were the land owner may get a small fee for the exclusivity and then if the plant is built an annual pay-out. Also, labour costs for the different studies occur in this phase.

4.2.2 Planning⁷⁰

4.2.2.1 Activities

The initial activity in this phase is to conduct on site measurements about the resource potential for the RES. For example measuring the actual wind or sunshine over an extended period of time. The planning phase's main focus is often closely connected with securing all needed permits for the construction. Many countries demand the developer to perform an EIA (Environmental Impact Assessment) on the site and surroundings. An EIA approval from the acting authority is essential to even be considered for building permits. Other political bodies may also have interest in the matter so the developer may need to secure their approval as well.

⁷⁰ (Seabased, 2013a)

During this phase the developer and grid owner must also determine how the plant is to be connected to the grid. The size of the plant(s) and its layout must be in its final stages in order to determine the specifications needed to connect to the grid.

4.2.2.2 Stakeholders

The planning phase has a great deal of stakeholders. The authorities such as regional departments as well as the municipality have a great deal of power in the case of energy production. They approve the EIA and permits needed and may even have a veto against the project.

The grid owners are a key player too as the plant must somehow connect to the grid. Many countries have legislated that a production plant cannot be denied connection to the grid. However, all costs needed to connect are usually covered by the developer.

The public has a strong say in the planning phase. Studies have shown that the overall public often are supportive of the expansion of WDRES, though the exception is often expressed as NIMBY (not in my backyard). People living close to the plants often have strong opinions and put pressure on the authorities.

Since some of the activities in this phase concern very detailed matters it is not uncommon that developers hire consultants to perform for example the EIA. Sometimes they might even hire experts in certain areas to completely explore the issue.

4.2.2.3 Cost/revenue

The costs that occur in this phase are labour and/or consultant fees to produce the EIA and other data in order to achieve the permits. The permits themselves may carry fees. Also, the equipment needed to measure the resources carry a cost.

4.2.3 Execution - Establishment

4.2.3.1 Activities

In this phase the needed permits for construction are achieved. Most WDRES are part of a subsidy support scheme which the developer often applies for in this phase. They must also secure a license to sell the produced electricity.

This is also the phase when the developer start to take tendering for the construction and other parts that need to be built such as infrastructure. The developer may even start to sign contractors in this phase.

4.2.3.2 Stakeholders

The authorities are still present in this phase as to acknowledge the connection to the presumed subsidy scheme and licensing to sell electricity. The OEM and construction contractors are also major stakeholders during the tendering of offers to build the plant as efficiently and cost/effective as possible.

4.2.3.3 Cost/revenue

The main cost in this phase is only the labour costs bound to the project process.

4.2.4 Execution - Realisation⁷¹

4.2.4.1 Activities

In this phase the actual construction starts and sub-activities may be:

- Electrical work
- Foundation
- Transportation infrastructure
- Delivery and installation of generators

4.2.4.2 Stakeholders

The key stakeholders are the chosen OEMs and contractors.

4.2.4.3 Cost/revenue

The realisation phase carries the main costs as the construction takes place. The power plant is bought in this phase, as well as all civil and electrical work surrounding the project. Depending on the WDRES labour costs are present, or included in the package when procuring the plant.

4.2.5 Execution - Hand-over

This phase is a combination of the last two phases in the original XLPM model.

4.2.5.1 Activities

In this phase the plant may start its commercial operation. It is common that the developer team hand-over the process to the generation team that

⁷¹ (Seabased, 2013b)

oversees the operation. Some developers choose to use external firms to take care of the operation and maintenance.

4.2.5.2 Stakeholders

The internal hand-over between teams could be considered a stakeholder in this phase. Also, the team or external party that will oversee the O&M of the plant.

4.2.5.3 Cost/revenue

Costs could include setting up an O&M team to take care of the generation.

4.2.6 Generation

This phase is established in order to modify the XLPM project model to a life cycle model.

4.2.6.1 Activities

The main activity here is to produce electricity and make sure that the plant is running at capacity at all times.

4.2.6.2 Stakeholders

It is not uncommon that the developer has to sign a contract with the main grid operator to ensure its production so the operator can create balance in the grid at all times. Thus both the grid owner and the electricity market are stakeholders during the operation, as well as the O&M.

4.2.6.3 Financials

At this point revenues from sales and subsidies hopefully are creating a positive cash flow. The costs during generations are O&M, possibly taxes and the grid connection often incurs a small fee related to the production.

4.3 Evaluation

The evaluation in the CL²-model is bicameral; both qualitative and quantitative. The MA will most likely have gathered more qualitative information concerning the market, while the lifecycle part probably will have gathered both qualitative and quantitative information.

4.3.1 Qualitative analysis

The qualitative analysis should follow the MA categorisation by starting to consider the global factors and then continuously march down the pyramid until the actual WDRES market analysis is completed. Then the lifecycle as a whole should be qualitatively analysed.

4.3.2 Quantitative analysis

Due to the nature of an investment in WDRES with a long process before realization the capital budgeting is divided up according to the different phases. From chapter 3 the nominal present value is determined by:

$$NPV = \sum_{n=0}^N \frac{CB_n * (1+i)^n}{(1+r)^n} - \sum_{n=0}^N \frac{CC_n * (1+i)^n}{(1+r)^n}$$

This study will however evaluate the IRR, thus $NPV = 0$ to calculate the IRR (r) of the investment. The cash flow in the different phases differs as some costs could be considered as fixed, while others are bound by i.e. the size of the plant or installed capacity. The generalised model is presented below:

$$NPV = - \sum_{n=1}^{t_1} \frac{CC_n * (1+i_n)^n}{(1+r)^n} - \sum_{n=1+\sum_{m=1}^2 t_m}^{\sum_{m=1}^2 t_m} \frac{CC_n * (1+i_n)^n}{(1+r)^n} - \sum_{n=1+\sum_{m=1}^3 t_m}^{\sum_{m=1}^3 t_m} \frac{CC_n * (1+i_n)^n}{(1+r)^n} - \sum_{n=1+\sum_{m=1}^4 t_m}^{\sum_{m=1}^4 t_m} \frac{CC_n * (1+i_n)^n}{(1+r)^n} - \sum_{n=1+\sum_{m=1}^5 t_m}^{\sum_{m=1}^5 t_m} \frac{CC_n * (1+i_n)^n}{(1+r)^n} + \sum_{n=1+\sum t_m}^{\sum t_m + N} \frac{CB_n * (1+i_n)^n}{(1+r)^n} - \sum_{n=1+\sum t_m}^{\sum t_m + N} \frac{CC_n * (1+i_n)^n}{(1+r)^n} = 0$$

Where,

- $m =$ phase m in the project
- $t_m =$ time of phase m in years; $t_m \in \mathbb{N}$
- $N =$ lifespan of the investment
- $i_n =$ the predicted inflation year n

The first sum corresponds to the cash flow in phase one, the second sum to phase two, and so on. Except for the last two sums which both corresponds to the generation phase. They could be bundled but are intentionally separated to help visualize the sum of positive cash flow.

To calculate the LCOE:

$$LCOE = \frac{\sum_{n=1}^{\Sigma t_m + N} \frac{CC_n * (1 + i_n)^n}{(1 + r)^n}}{\sum_{n=1}^{\Sigma t_m + N} \frac{E_n}{(1 + r)^n}}$$

5 Case study - Finland

The interesting traits of the wind power market in Finland make it an excellent market to apply the CL²-model and evaluate its attractiveness. At first the market is assessed from a global standpoint and step-by-step converge towards the national wind power industry. Step two is a break down the life cycle of a wind farm where all activities, stakeholders and cost/benefits are mapped for each phase.

5.1 Market assessment

The initial step in using the model is to assess what influences electricity generating industry from a global to a, in this case, wind power specific way.

5.1.1 Global

The main factors affecting the wind power industry in Finland are global economic trends and multi-national agreements particularly concerning the climate and energy.

5.1.1.1 As/is

5.1.1.1.1 Global politics, legislation, and agreements

The United Nations Framework Convention on Climate Change (UNFCCC) arrange the Conference for the Parties (COP) meetings where leaders from all over the world come together to discuss climate matters. The last meeting was COP19 during 11-22 November 2013 in Warsaw, Poland and the next one is COP20 held in Lima, Peru during 1-12 December 2014. Like most meetings, the actual results from COP19 did not lead to a global agreement and was thereby criticised by environmentalists all over the world.⁷²

One of the most well-known international agreements related to the climate issue is the Kyoto Protocol. It was adopted in Kyoto, Japan in December 1997 and became active in February 2005. All countries agreeing to the protocol has committed to binding emission reduction targets. The protocol issues differentiated burden for different countries under the principle “common but differentiated responsibilities”. The Kyoto Protocol is seen as a first step towards a unilateral target on emissions reduction and also as a potential framework on how to structure future global agreements concerning the climate issue.⁷³

⁷² (Bach, et al., 2013)

⁷³ (UNFCCC, 2014a)

5.1.1.1.2 EU politics and legislation

Over the last decades, increased authority has been transferred to the EU by its member state. This has led to increased integration between the member states, but in some ways also reduced the authority of the national governments. *The 2020 climate and energy package* is one of these binding legislations in which the “20-20-20” targets are defined. The three objectives to be reached by 2020 are:

- Reduce GHG emissions by 20 % from 1990’s level.
- Improve energy efficiency by 20 %.
- Increase share of energy produced with renewable resources to 20 % of the final energy consumption.

The targets are to be reached by the EU27 as on entity. The package contained legislations in order to reach the targets, mainly around four types of measures⁷⁴:

1. Reforming the EU Emissions trading system (EU ETS). The EU ETS is considered a cost-efficient system to reduce the GHG emissions and the reformation strengthened the purpose of the existing system and introduced a greater cap-reduction each year until 2020. The emissions level 2020 are supposed to be 21 % lower than the base level 2005.
2. National targets for non-EU ETS emissions. As all industries are not covered by the EU ETS the member states were obliged to meet national targets which were set under the so-called “effort-sharing decision”. A majority of the GHG emissions came from industries not covered by the EU ETS. The respectively targets were set according to the member state’s relative wealth, which ranged between a 20 % decrease to a 20 % increase in emissions.
3. National renewable energy targets. The burden between member states were differentiated in the target definitions, though the criteria now was the state’s starting point and the estimated potential for increased renewable production.
4. Carbon capture and storage (CCS). A legal framework for environmentally safe CCS was introduced and covers all kinds of CO₂ storage within the union and what criteria must be fulfilled.

⁷⁴ (European Commission, 2014a)

5.1.1.1.3 Conflicts

The most recent conflict blew up in early 2014 as the Ukrainian government was overthrown after protests and an eventual revolution in the capital Kiev. Shortly thereafter Russia made movements towards the Ukrainian peninsula Crimea, a region with close ties to Russian history and culture, as well with a large ethnic Russian population. So called “local self-defence groups” started seizing important governmental buildings and infrastructure on Crimea with support from Russian troops. On March 16th a referendum to leave Ukraine and join Russia was passed with almost 97 % of the votes, and a few days later Russia formally annexed Crimea. Ukraine, the EU, and the US have all opposed to the annexation of Crimea and ordered sanctions towards people involved in the conflict, especially people in the close vicinity of Russian president Vladimir Putin.⁷⁵

An important part of the Crimea crisis is connected to energy. Several countries in the EU are heavily dependent on Russian gas, not the least Germany after closing down all its nuclear power plants. Ukraine is also dependent on the Russian gas. Several pipelines are passing through Ukrainian territory resulting in a steady cash flow for the nation, as well as great availability to the fuel. Due to Russia’s leverage towards the EU, the 2030 goals, described in the next chapter, have been somewhat disregarded as the issue of the dependency of Russian gas have risen in the agenda⁷⁶.

5.1.1.2 Future

There is continuous work going on between the COP-meetings in order to try and establish a framework that all countries will ratify in the pursuit of lowering the GHG emissions. However, by looking at the history of these meetings and the outcomes it is impossible to predict if a breakthrough will happen. For example, the US has yet to sign the Kyoto Protocol and has claimed the main reason to be that the roof of emissions will greatly harm the domestic economy⁷⁷.

On 22 January 2014 the European Commission proposed a new framework with objectives to be reached by 2030. The European Parliament did its first reading of the communication on February 5th, were it adopted a resolution on a 2030 framework for climate and energy policies. However, the Parliament

⁷⁵ (Yuhás, 2014)

⁷⁶ (Conca, 2014)

⁷⁷ (UNFCCC, 2014b)

regarded the communication as short-sighted and unambitious and proposed counter-targets shown in table 1.

Targets suggested by the Commission	Targets proposed by the Parliament
40 % cut in GHG emissions (1990's level)	At least 40 % cut in GHG emissions (1990's level)
Renewable energy production to be at least 27 % of final energy consumption	Renewable energy production to be at least 30 % of final energy consumption
Energy efficiency important but no specific target	Energy efficiency target of 40 %

Table 1: The proposed 2030-targets on EU-level⁷⁸

The Commission and the European Council were to review the proposal and its changes during the spring of 2014, but due to the Crimea crisis this review has been put on hold. Instead the issue of energy independency from Russia and energy security are on the agenda and how the EU may reach those goals.⁷⁹

5.1.1.3 Risks

The world is still feeling the aftermath from the recent financial crisis and different countries and regions have recovered better than others. The euro zone still faces both political and economic obstacles but is at least not in recession anymore. Still, the euro zone experiences record high unemployment rates and a bank sector that still cannot supply the market with credit in a needed way. During 2015, SEB predicts that the American Federal Reserve Bank phase out its purchases of securities and start raising its interest rate. Also, Bank of England and the Scandinavian central banks are predicted raise their key interest rates.⁸⁰

The political and economic turbulence in the world affects the risks of investment in RES. As most RES still are relying on subsidies, the state finances are crucial to the developers. Spain was a precursor in the development of RES guaranteeing the developers long term feed-in tariffs. The goal was to attract investors and decrease the fossil fuel dependence. The financial crisis hit Spain hard and basically depleted its assets. To cope with that the generous subsidies were reduced continuously⁸¹. From 2014 onward 37 % of the installed Spanish wind capacity does not receive the subsidy any

⁷⁸ (European Parliament, 2014)

⁷⁹ (Bloomberg, 2014)

⁸⁰ (SEB Economic Research, 2014a)

⁸¹ (PRI, 2013)

longer and the rest will see it cut further to a “reasonable” return of 7.5 %. The investment in Spanish wind power has plunged and many thousands of jobs have been lost.⁸²

The recent and ongoing conflict concerning the Crimean peninsula seems to have at least temporary redirected the political agenda of increasing the share of renewable energy to the matter of independency from Russia.

5.1.2 Finland

Finland is situated in north-eastern Europe with borders towards Russia, Sweden, Norway and Estonia.



Figure 12: A map of Finland and its main regions⁸³

⁸² (The Daily Caller, 2014)

⁸³ (locations4business, 2013)

Finland is the seventh largest country in Europe but only has around 5.4 million inhabitants where 1.25 of them lives in the capital Helsinki on the south coast. The main exported goods are information and communications technology (ICT), metal, wood and paper products and chemicals, while energy and consumer goods are important imports⁸⁴. Both Finnish and Swedish are official languages, but the share of Finns being bilingual is slowly decreasing.

5.1.2.1 As/is

Finland was declared independent in December 1917 after being both Russian and Swedish in the previous centuries. It is a republic with parliamentary democracy. The election for parliament is held every fourth year (next one 2015) for the 200 member seats. The head of state, President of the Republic, is elected every sixth year. President Sauli Niinistö was elected in 2012.⁸⁵

The current cabinet is led by Prime Minister Jyrki Katainen from the National Coalition Party (NCP) and consist of a coalition between five different parties (used to be six but The Left Alliance left the government April 4th 2014)⁸⁶. The Centre Party (CP) was the largest party in the 2007 elections but lost more than 7.5 % of the support in the 2011 election. On the other hand, the Finns Party (FP) increased their support with 15.0 % to become the third largest party with 19.1 % of the votes.⁸⁷ The FP is EU-sceptic and is Finland's response on the political nationalistic trend that has swept across Europe over the last decade. Finland has been a member of the UN since 1955 and the EU since 1995.

Finland is currently the Nordic country whose economy shows the least promising signs of improvement. The export's share of GDP has decreased by 10 % since 2008, mainly by a decreased demand of forestry and ICT-products. The domestic households have been resistant during the recession, but rapidly increased unemployment rates and tax increases are taking its tolls. The unemployment and low economic growth counter all austerities that have affected the state budget. The state deficit is constantly growing and expected to reach and stabilise around 60 % of the GDP in 2014.⁸⁸

⁸⁴ (thisisFINLAND, 2014)

⁸⁵ IBID

⁸⁶ (Finnish Government, 2014)

⁸⁷ (Official Statistics of Finland (OSF), 2011)

⁸⁸ (SEB Economic Research, 2014a; SEB Economic Research, 2014b)

On May 15th 2014 the OSF published preliminary statistics which showed a decreased BNP-indicator by 0.4 % for Q1. Since the BNP shrank Q4 2013 too, Finland is now in a technical recession. Final statistics are to be published June 5th 2014, but it is probable that Finland now is in its third recession within six years. The number of employed people is estimated to have decreased by 0.5 % compared to the year before.⁸⁹

In order to stabilise the state deficit the government introduced cuts in welfare spending for the next budget. The child support and unemployment benefits were two benefits to receive cuts, which led to the resignation of the Left Alliance on April 4th 2014 due to not being able to accept cuts related to low-income citizens. The acquittal of the Left Alliance has led to a weakening of the current government as the current coalition now have 112 out of the 200 seats in the parliament.⁹⁰

Only a day after the Left Alliance left the government, current Prime Minister Katainen announced on April 5th that he is not to seek re-election as the chairman of the NCP this summer⁹¹. The full extent of this is that Katainen is to resign his ministerial post in June 2014, well in advance of the next election. Rumours indicate that he is aiming for a high-level assignment in the EU. Meanwhile, the head of Social Democratic Party (SDP) and Minister of Finance, Jutta Urpilainen, was being challenged from within⁹². If defeated, she announced that she would resign as Ministry of Finance⁹³. On May 8th 2014 the SDP voted on its yearly congress and Urpilainen lost to Antti Rinne by 258 against 243 votes and is resigning her ministerial post in the summer⁹⁴. On May 28th Antti Rinne announced that he will succeed Urpilainen as the new Minister of Finance⁹⁵.

Due to all these announcements since April 1st, the opposition has been driving the question of re-elections, but President Niinistö has announced that the constitution does not demand it⁹⁶.

⁸⁹ (Official Statistics of Finland (OSF), 2014b; SEB Economic Research, 2014b)

⁹⁰ (Reuters, 2014; Embassy of Finland, 2014)

⁹¹ (yle, 2014a)

⁹² (yle, 2014b)

⁹³ (yle, 2014c)

⁹⁴ (Bloomberg, 2014)

⁹⁵ (yle, 2014e)

⁹⁶ (yle, 2014d)

Solidium is an LLC fully owned by the state of Finland whose main mission is to strengthen the Finnish ownership in vital domestic companies⁹⁷. The intention was to run the company without political interference, but there have been claims that this has not been the case over the last couple of years. *Solidium* has been a stable cash cow of the government, but has over the last few years made some devastating investments. The mine *Talvivaara* has been leaking environmentally hazardous substances for almost two years and has run out of capital more than once⁹⁸. So *Solidium* has against better judgement invested more, all in all ~150 MEUR. Today, the accumulated investment is worth ~18 MEUR⁹⁹. Meanwhile another core holding, steel producer *Outokumpu Oyj*, ran into huge liquidity problems announcing a plan to issue new shares of a value of 650MEUR. *Solidium* had to invest almost 200MEUR to not dilute the current share of shares¹⁰⁰. Despite this, the government put pressure on *Solidium* to pay out the expected dividends which ultimately led to *Solidium* having to sell shares in the insurance company *Sampo* for a value of 800MEUR in mid-February 2014¹⁰¹.

Finland was in 2013 considered the third least corrupted country in the public sector and has performed well in similar rankings over a long period of time¹⁰². The Finns are considered to hold true to their word; once a decision or promise has been given they tend to follow through¹⁰³.

Finland left its own currency, the mark, behind in 2002 for the mutual European currency the Euro¹⁰⁴. Thus, Finland is part of the Euro system which covers the European Central Bank (ECB) and other central banks in the member countries. Finland's central bank is the Bank of Finland (BiF) which manages objectives related to both European and domestic strategies¹⁰⁵. Finland's inflation is closely correlated with the inflation in the Eurozone which is called *the Harmonised Index of Consumer Prices* (HICP). The ECB

⁹⁷ (Solidium, 2014a)

⁹⁸ (Wallén, 2014)

⁹⁹ (Solidium, 2014b)

¹⁰⁰ (Wallén, 2014)

¹⁰¹ (Solidium, 2014)

¹⁰² (Transparency International, 2013)

¹⁰³ (Liukko, 2014a; Niinistö, 2014)

¹⁰⁴ (Utrikesministeriet, 2011)

¹⁰⁵ (Bank of Finland, 2014)

strives to maintain price stability and aims at inflation rates just below 2 % in medium term¹⁰⁶.

The ongoing conflict concerning the Russian annexation of Crimea, which was an autonomous republic administered by Ukraine until February 2014, directly impacts Finland. The EU has made economic sanctions towards Russia, even though the European market is dependent on Russian natural gas. This poses a problem for Finland, whom imports all its consumed natural gas from Russia today¹⁰⁷. Over all, Russia is one of Finland's most important trade partners as roughly 8.5 % of its exports go to Russia and 18 % of its imports come from Russia¹⁰⁸.

5.1.2.2 Future

The political turbulence in Finland with parties leaving the government and the two highest politicians resigning from their ministerial posts a year in advance of the next election damages Finland's reputation. This along with the weak economy has led to Standard & Poor to give Finland's AAA credit rating a negative outlook.¹⁰⁹

The expected inflation rate in Finland is predicted to be slightly higher than the eurozone's, growing by 1.4 - 1.7 % over 2014 and 2015.¹¹⁰

The conflict in Crimea has made impact on Finland, but even more so on the other Baltic states. Especially Estonia and Latvia have large populations of Russian minorities, just like Crimea. Russian president Vladimir Putin's decisive actions to protect ethnic Russians have led to fear that he will continue to military liberalise the mentioned countries. Former US secretary of state, Hillary Clinton, compares Putin's actions to Adolf Hitler's when he in the 1930s went into Czechoslovakia and Romania to protect German minorities.¹¹¹

5.1.2.3 Risks

The issues of creating growth in the Finnish economy pose a threat as it hampers both production and investments. Meanwhile there is an unusual

¹⁰⁶ (European Central Bank, 2014)

¹⁰⁷ (Staalesen, 2014)

¹⁰⁸ (OEC, 2014)

¹⁰⁹ (SEB Economic Research, 2014b)

¹¹⁰ (SEB Economic Research, 2014a; European Commission, 2014b; SEB Economic Research, 2014b)

¹¹¹ (The Guardian, 2014; Easton, 2014)

turbulence in the politics, not the least that two of the leaders seem to be resigning before the next elections. The rapid increase of support for the Finns party could turn out to be problematic as they are anti-EU while the Finnish economy is dependent on foreign trade.

As mentioned earlier, there are those who acknowledge the Russian threat on Finland's sovereignty, but other states are most likely more worried. However, if the conflict progresses and the EU increase its sanctions towards Russia, and especially the trade, major issues will arise in Finland.

5.1.3 Energy

5.1.3.1 As/is

5.1.3.1.1 Politics

Due to the recent proposal of the 2030 framework described in section 5.1.1.1, there has been no purpose for Finland to modify its national energy and climate strategies. The current strategy proposal was sent to the Finnish parliament on March 20th 2013 and the publication title was "National Energy and Climate Strategy" (NECS). The overall targets correlate well with the 20-20-20 targets for EU, but as seen in table 2 below a few targets differ.

Targets for 2020	The EU	Finland
Reduction of GHG emissions¹⁾	- 20 %	EU-level target
ETS emissions ²⁾	- 21 %	EU-level target
Non-ETS emissions ²⁾	- 10 %	- 16 %
Share of renewable energy sources in final energy consumption	20 %	38 %
Share of biofuel in transport fuels	10 %	20 %
Improving energy efficiency³⁾	+ 20 %	EU-level target
1) Base year 1990		
2) Base year 2005		
3) In comparison to development as estimated 2007		

Table 2: Finland's national and climate targets¹¹²

Table 2 show three targets which differentiate. The EU has set the increased target for reductions in GHG non-ETS emissions and the considerably higher share of renewable energy production. Finland itself has decided of an increased share of biofuel in transport fuels. Finland also strives to become self-sufficient in electricity sourcing and not be dependent on electricity imports, especially during the winter.

¹¹² (Finland's Ministry of Employment and the Economy, 2013)

As the process in EU of determining energy and climate goals towards 2030, the government has acknowledged that legislation will show up eventually and that Finland must be prepared. A proposal in the NECS is that Finland should decrease focus on the costs that the climate policies introduce and instead focus on the opportunities and advantages of the policies. The development towards a low GHG emissions society presents big opportunities for the Finnish trade and industry.

5.1.3.1.1.1 Renewable targets

In 2012 34.3 % of the Finnish energy consumption came from renewable energy sources.¹¹³ The NECS state that the target of a 38 % share of renewable energy sources in the final energy consumption should be met by 2020 through previously decided actions. As mentioned in the previous section the government admit the opportunities the climate policies and legislations bring. This has led to a desire to create a national cleantech cluster, comparable to what Silicon Valley is for IT. The goal is that the national cleantech industry should turnover €40 billion and have created 40 000 new jobs by 2020.¹¹⁴

5.1.3.1.2 The electricity market

Finland's electricity mix has developed over the last 40 years from being dependent on hydro power to be much more dependent on nuclear power as seen in figure 13.

¹¹³ (Eurostat, 2014)

¹¹⁴ (Sitra, 2007)

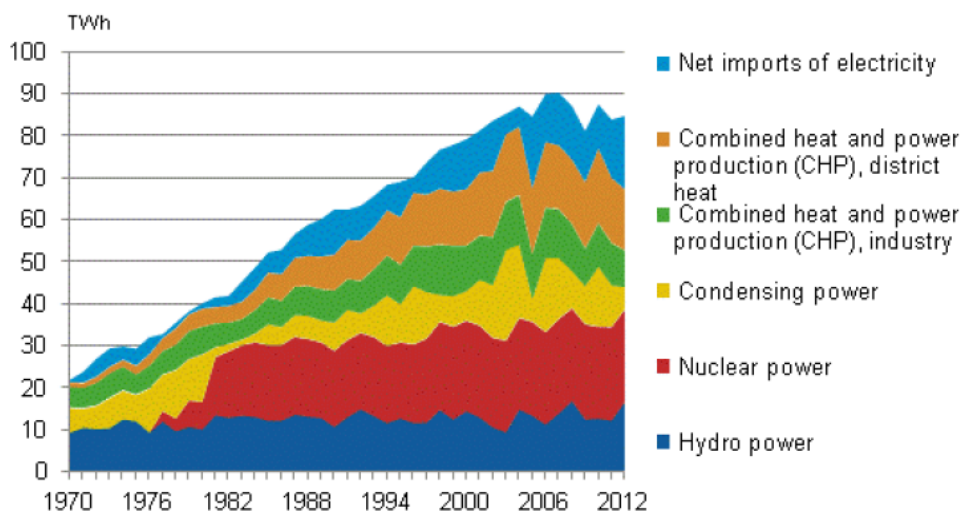


Figure 13: Electric supply 1970-2012¹¹⁵

The chart above only concerns the main energy sources used in production of electricity. It shows that the produced hydro power has remained steady over the years as the introduction of nuclear power in the late 70's now act as the main supplier. The production increased steadily until around 2003 and has experienced high volatility since. Importantly, Finland has had to import electricity since the statistics was introduced. As seen in the graph, net imports were about 15 TWh in 2012, around 20 % of the total electricity consumption. As stated in section 5.1.3.1.1 the Finnish government has a goal of self-sufficiency in electricity production thus a huge gap needs to be filled.

5.1.3.1.2.1 Energy sources

A brief summary of the main energy sources in Finland.

5.1.3.1.2.1.1 Nuclear power

Finland has four operating nuclear reactors which are considered among the world's most efficient ones. *Teollisuuden Voima Oy* (TVO) operates two Asea Atom boiling water reactors in the Olkiluoto nuclear plant and *Fortum Corporation* operates two Russian pressurised water reactors and steam generators in the Loviisa nuclear plant¹¹⁶. Since the first reactor begun operation in 1977 all four of the reactors have been continuously upgraded and especially TVO's reactors have increased their efficiency by over 30 %.

¹¹⁵ (Official Statistics of Finland (OSF), 2013)

¹¹⁶ (Fortum, 2009)

Name	Type	MWe net	First power	Expected shutdown
Loviisa 1	VVER-440/V-213	496	1977	2027
Loviisa 2	VVER-440/V-213	496	1981	2030
Olkiluoto 1	BWR	880	1978	2039
Olkiluoto 2	BWR	880	1980	2042
Total (4)		2741		

Table 3: Overview of the nuclear reactors in Finland¹¹⁷

The operating nuclear reactors are listed in table 3 above and as seen the net capacity installed is 2.7 GWe which in 2012 corresponded to approximately 23 TWh produced electricity (26 % of the total consumption).¹¹⁸

5.1.3.1.2.1.2 Renewables

Hydro power was introduced in Finland in the 1920's and *Imatra* was back then the largest hydro power plant in Europe¹¹⁹. However, the lack of mountains (compared to Sweden and Norway) in Finland affects the possible expansion of hydro power. Instead the rich landmasses of forest and thus wood fuels have been exploited as Finland has a well-developed CHP-industry to supply electricity and heat to the citizens.

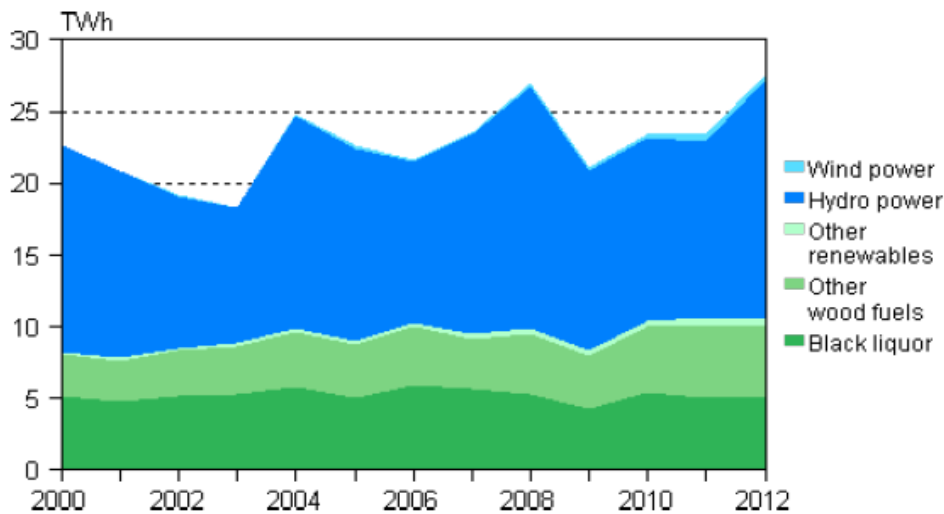


Figure 14: Electricity generation with renewables 2000-2012¹²⁰

¹¹⁷ (Fortum, 2014)

¹¹⁸ (World Nuclear Association, 2014)

¹¹⁹ (Statistikcentralen, 2007)

¹²⁰ (Official Statistics of Finland (OSF), 2013)

Figure 14 show the electricity generation from renewable energy sources since 2000. The hydro power's volatile curve could be explained by the seasonal variations of the water levels in the power plants. The green curves represent combustion of different kinds of biomass, which corresponds to about 15 % of the total electricity production. Notably, the wind power's share is virtually negligible.

5.1.3.1.2.1.2.1 Hydro power

Finland has around 250 hydro power plants with a nominal installed capacity of 3 111 MW (2012-01-01)¹²¹. As there are strict regulations concerning environmental impact, all favourable sites for new-development are practically protected. This has led to a slight increase in installed capacity over the last decades, mainly due to upgrades in existing plants or minor plants being constructed. Seven hydro plants have installed capacity over 100 MW, and there are no signs of further expansion of hydro plants of that magnitude in the foreseeable future.

The main actors are *Fortum*, *Kemijoki Oy*, *Pohjolan Voima (PVO)* and *UPM Kymmene (UPM)* which constitute over 80 % of the market. The definite owner-structure is unknown as many plants are co-owned, for instance UPM is a minor shareholder in both Kemijoki and PVO.¹²²

5.1.3.1.2.1.2.2 Biomass

As seen in figure 14, combustion of biomass such as black liquor, and other concentrated liquors, and other wood fuels stands for a considerable share of Finland's electricity production. Compared to the rest of Europe, Finland resides in the top along with Denmark¹²³.

Many of the old combustion plants relied heavily on fossil fuels, but to adapt to legislation many of them have made upgrades to use renewable fuels efficiently as well. It is common that the power plants are of CHP character which means combined heat and power production. Thus the plants generate both electricity to the grid and heat to the widely developed district heating system in the different Finnish regions.

¹²¹ (Statistikcentralen, 2012)

¹²² (PwC, 2013)

¹²³ (Obernberger & Thek, 2008)

5.1.3.1.2.2 *Import and export*

As seen in figure 13 Finland heavily relies on net import of electricity. In 1995 the government started deregulating the electricity market and in 1998 Finland joined Nord Pool.

5.1.3.1.2.2.1 *Nord Pool Spot Exchange*¹²⁴

Nord Pool is the leading power market in Europe and is owned by the transmission system operators *Statnett SF* (Norway), *Svenska Kraftnät* (Sweden), *Fingrid Oyj* (Finland), *Energinet.dk* (Denmark), *Elering* (Estonia), *Litgrid* (Lithuania) and *Augstsprieguma tikls* (Latvia). Most of the produced electricity in the Nordic and Baltic countries is sold through Nord Pool at a competitive price.

The national transmission grids are getting more and more integrated in northern Europe. There are several direct current (DC) transmission connections between the Nordic countries as well as to other neighbouring countries. The Finnish grid is connected to the Swedish and the Norwegian in the north, the Swedish in the south-west, the Estonian in the south and the Russian in the south-east.

As seen in figure 13 Finland has to net import electricity to cover the domestic demand. During the last few years two major trends have been distinguishable: a rapid increase in net imports of Swedish hydro power and decrease in net imports from Russia¹²⁵. The hastily decline in imports from Russia is caused by a change in the Russian market model as exported electricity now carries a capacity fee during certain times of the day. The fee has made the Russian electricity more expensive than the domestic; or actually Swedish hydroelectricity.¹²⁶

In figure 15 below the flow of electricity between electricity areas and the prices at 17.08 on March 3rd is shown.

¹²⁴ (Nord Pool Spot, 2014a)

¹²⁵ (Finnish Energy Industries, 2013)

¹²⁶ (The Energy Authority, 2013)

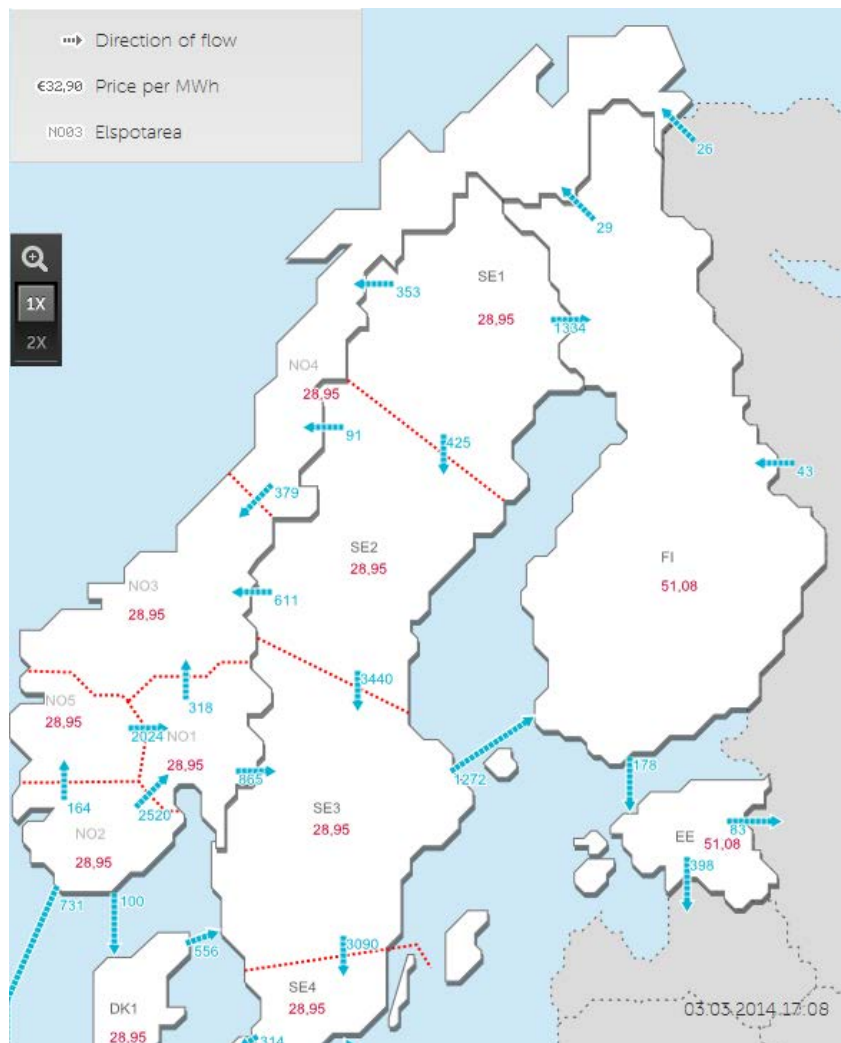


Figure 15: The Nordic power system, price and flow at 17.08 2014-03-03¹²⁷

As seen above, Finland is the only Nordic country without specific electricity areas. Also, the demand seems higher in Finland as the price is considerably higher and the flow is close to maximum transmission capacity.

5.1.3.1.3 The spot price

As mentioned above, most generated electricity is sold on the Nord Pool spot exchange.

¹²⁷ (Fingrid, 2014a)

Monthly spot price on Nord Pool in price area Finland

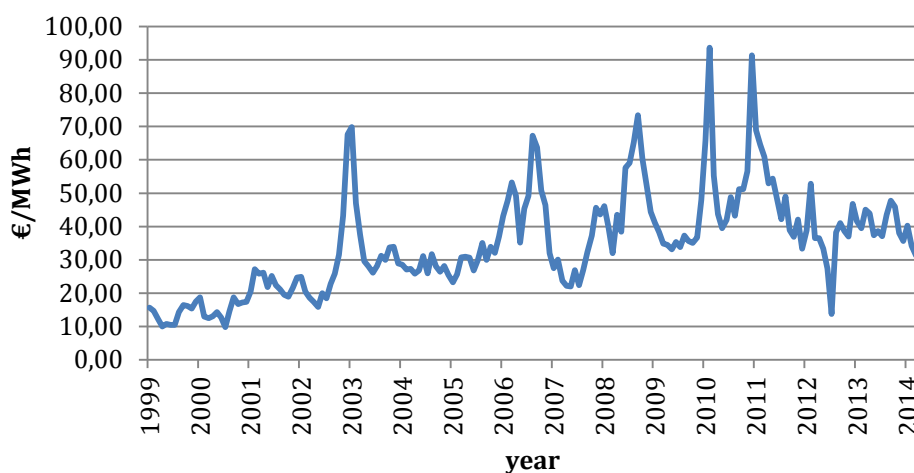


Figure 16: The historic spot price on Nord Pool in Finland¹²⁸

As seen above, the spot price is highly volatile which is problematic for the electricity producers. The uncertainties in the revenue streams are often hedged with long-term power purchase agreements to decrease the volatility.

5.1.3.2 Future

The NECS is focused on the expansion of nuclear and wind power to meet energy independency as well as EU targets. Further expansion of hydro power is possible on small-scale plants, but there are very few possible sites to build larger plants. The repowering of old combustion plants to accommodate renewable fuels is likely to continue.¹²⁹

The shared electricity market in the Nordic countries is likely to integrate further with the long-term EU goal of a fully integrated market. New cross-border transmission lines are in the pipeline, as well as increased capacity on some of the current lines. For example another transmission line is to be built between Finland and Estonia and the connection Finland-Sweden in the north is to get increased transmission capacity.¹³⁰

¹²⁸ (Nord Pool Spot, 2014b)

¹²⁹ (Finland's Ministry of Employment and the Economy, 2013)

¹³⁰ (Fingrid, 2013)

5.1.3.2.1 Nuclear expansion

The Finnish parliament approved the building of a new nuclear reactor in 2002, the first approval in all of Europe for over ten years. The reactor was planned to be operational by 2009, and be built by TVO next to the other two reactors in the Olkiluoto plant. The construction started in 2005 and by then the reactor was projected to be in operation by 2013. Since then severe delays have occurred and the latest reports suggest commercial operation in 2016. The unsuccessful development has increased the uncertainty in building additional reactors, and there is an infected conflict between TVO and the project suppliers; *Areva-Siemens* consortium. Olkiluoto 3 is a European Pressurised Reactor (EPR), the first of its kind with net installed capacity of 1 600 MWe. Thus when operational the produced nuclear power will increase by 60 % compared to today.¹³¹

The pipeline contains two more projects: Olkiluoto 4 and Hanhikivi 1. Olkiluoto 4 was planned to begin construction in 2015, but will be postponed as the application for building permit is not handed in yet, and of equal size to Olkiluoto 3¹³². Hanhikivi 1 is owned by Fennovoima, a consortium of some 60 industry and energy companies. The owner-structure has changed over time as *E.ON* had a large share but left the project. In December 2013 Russian *Rosatom Overseas* joined the venture¹³³. The construction of the ~1 100 MWe reactor was supposed to begin within a few years and the reactor is supposed to be commercially operational in 2024. However, due to the development in the owner structure, the permit must be retried in the Parliament¹³⁴.

5.1.3.2.2 Spot price

Predicting the future spot price is impossible but a necessity to be able to make investment calculations. The Nordic and Baltic markets are getting more integrated, thus making the spot price less dependent on the national production and consumption.

¹³¹ (World Nuclear Association, 2014)

¹³² IBID

¹³³ (Fennovoima, 2014)

¹³⁴ (Liukko, 2014a)

Spot price prognosis in price area Finland

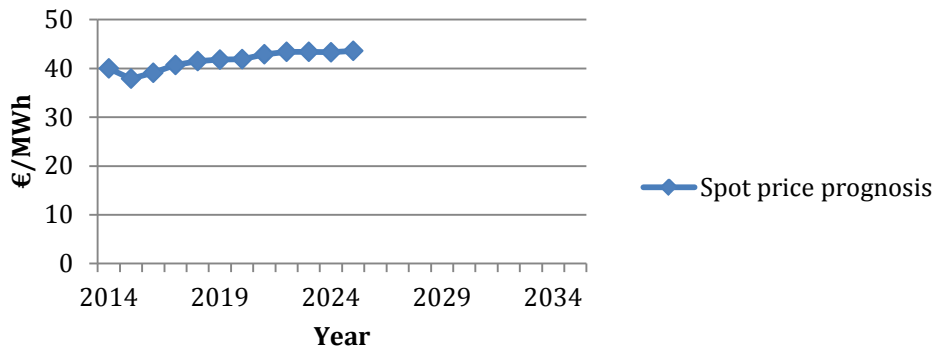


Figure 17: Prognosis of the future spot price in Finland¹³⁵

The prognosis in figure 17 above was created in September 2012 by Markedskraft, a Norwegian consultancy service in the energy sector. Most energy companies and utilities have long-term expectations of the electricity price but these are trade secrets¹³⁶.

5.1.3.3 EU's renewables directive¹³⁷

The island of Åland situated between Sweden and Finland is connected to the Swedish grid. In 2010 wind producer *Ålands vindkraft* applied to be part of the Swedish certificate subsidy system, even though it is not a part of Sweden. The Swedish EA did not approve the application, a decision that was appealed in Swedish court. The case is now in the European Court of Justice, to be decided within a foreseeable future.

The big issue is if the national subsidy schemes are illegal due to the EU's laws of free movement of products and services within the union. If the court rules in favour of *Ålands Vindkraft* it means that producers of renewable energy in one country could apply for subsidies in another country if their system is more generous. The advocate-general uttered his opinion in the beginning of 2014 that *Ålands Vindkraft's* claim was in accordance with current legislation. The verdict has yet to come, but the possibility of the national subsidy schemes to be illegal has sparked concern in Europe.

¹³⁵ (Markedskraft, 2012)

¹³⁶ (Work document, 2014)

¹³⁷ (SVT Nyheter, 2014)

5.1.3.4 Risks

Finland's dependency on importing fossil fuels from Russia poses as mentioned earlier as a threat, especially since the arisen conflict in Crimea.

The problems concerning the building of new nuclear reactors affect the wishes of energy self-sufficiency. The installation of Olkiluoto 3 will take at least 7 years more than initially planned and the costs has increased too, which could affect the time-plan of Olkiluoto 4. The potential catastrophe due to a reactor meltdown is also a great risk that Finland takes.

5.1.4 Wind power

This chapter presents the market situation for wind power in Finland.

5.1.4.1 As/is

5.1.4.1.1 Politics

The government set a goal of 6 TWh installed wind power by the year of 2020 in 2008. The newest edition of NECS proposes another goal of 9 TWh installed capacity by 2025. The strategy acknowledge that the goals are unattainable given the current conditions as the permit process and all surrounding investigations are to complex and time-consuming. The Finnish market is still young and most production facilities exist of a few wind mills. The government is pushing for larger farms to practice the advantages of economies of scale.¹³⁸

In 2009 the government introduced a feed-in tariff system in which wind power is included. The tariff system is closely presented in section 5.1.4.1.4. Wind power is also the subject of certain political factors described in the next section.

5.1.4.1.1.1 Special factors

The last Finnish wind atlas show limitations in suitable locations for wind farms inland. The best wind conditions are found along the coast and out at sea. As of today there are no Finnish offshore farms only a solitary turbine, but there are some large projects in the pipeline. To both try and promote offshore projects, the Finnish government have budgeted a 20 MEUR investment support for a demonstration project, which developers could

¹³⁸ (Finland's Ministry of Employment and the Economy, 2013)

apply until the end of September 2013. The decision of who will get the support is to be determined in the autumn of 2014.¹³⁹

The Finnish parliament introduced a new act on July 1st 2013 to simplify wind development by creating compensation areas for wind power. Windmills are known to both interfere with low-flying aircrafts and disturb radar surveillance. The new act states that a wind mill built in a compensation area need not have the defensive forces to do a separate investigation concerning its impact on the territorial surveillance or military aviation. Also, previous vetoes from the military forces are withdrawn in these areas. Instead all wind farms built in the area are required to pay a fee for each of the turbines. The first compensation area to be specified is in the Bay of Botnia (around 2450 km²). The fee is €50 000 and the maximum amount to be collected in the area is MEUR 18.5.¹⁴⁰

5.1.4.1.2 The general public opinion on wind power

Finns in general have a positive attitude towards wind power but people living close to the turbines are more negative. 87 % of the Finns believe that the amount of wind power should increase; wind power was only outnumbered by solar but beat both biomass and hydro¹⁴¹. Another study found that 58 % of the Finns consider wind power as the most wanted means of electricity production, putting it ahead of waste and hydro also this time¹⁴². The annoyance of wind power does not decrease with the distance between the turbine and one's home. People living 1 km from a wind power plant feel as disturbed as people living 7 km away.¹⁴³

5.1.4.1.2.1 The national anti-wind organisation

In Finland a national anti-wind organisation called *Tuulivoimakansalaisyhdistys ry* exists. They claim to be ordinary Finns who feel that the wind development intrude on the wild life and destroys the beautiful countryside and woodlands where many Finns have a vacation cottage. Their criticism is also that the Finnish public is misinformed and that the only information available is that from wind developers themselves, their consultants and other pro-wind organizations. Another criticism is that the

¹³⁹ (Liukko, 2014b)

¹⁴⁰ (Ministry of Justice, 2013)

¹⁴¹ (Finnish Energy Industries, 2012)

¹⁴² (Virta, 2014)

¹⁴³ (Mikkonen, 2013)

subsidy system paid with tax incomes is way too generous and that the profits made are brought out of Finland to low tax countries.¹⁴⁴

Even though they (the anti-wind organisation) consist of a small number of individuals they have been loud and influential in the Finnish media¹⁴⁵. According to developers active in Sweden and Finland, the Finnish resistance to wind power is similar to that in Sweden and is not considered to be a big problem¹⁴⁶.

In addition to the national anti-wind organization local organization with the same purpose exists¹⁴⁷. One developer has experienced recent increases in the local resistance in their area of operations. This was expected as the awareness of the negative effects of wind power increase as more turbines are erected¹⁴⁸.

5.1.4.1.3 The current noise disturbance limits

The noise from wind turbines are mainly created by rotating rotor blades but also by the machinery. Larger rotors create more noise and the noise varies with the number of turbines, the wind speed and the distance to the observation site. For permanent residential areas they are 45 dB during daytime and 40 dB during night-time, in recreational areas they are stricter, 40 dB during daytime and 35 dB during night-time¹⁴⁹. Some areas use even stricter rules of 35 dB also during daytime in recreational areas¹⁵⁰.

5.1.4.1.4 The Finnish feed-in tariff subsidy

A feed-in tariff (FIT) is a subsidy for renewable energy production used in several countries. The system pays the producer of electricity a guaranteed price based on the cost of development for a fixed period of time. It increases the profitability and makes prognoses of future cash flows less uncertain, thus decreasing the risk and increasing the level of investment.¹⁵¹

The Finnish feed-in tariff subsidy is applied to the following types of electricity generation:

¹⁴⁴ (Nikula, 2014)

¹⁴⁵ (Paalatie, 2014)

¹⁴⁶ (Lundberg, 2014; Stormoen, 2014)

¹⁴⁷ (Paalatie, 2014)

¹⁴⁸ (Hillforth, 2014)

¹⁴⁹ (Ministry of the environment, 2012)

¹⁵⁰ (Hillforth, 2014)

¹⁵¹ (Couture & Gagnon, 2009)

- *“New wind power plants.*
- *New biogas power plants (gas produced by digestion).*
- *New wood-fuelled power plants which also produce heat for utilization.*
- *Timber chip power plants.”¹⁵²*

The feed-in tariff is described in this paragraph and with a graph in figure 18. The target price for electricity produced by a power plant in the system is €83.50/MWh. The tariff is the difference between the arithmetic average of the hourly electricity prices during the price period of three months and the target price. The tariff is paid after the end of the price period and a year is divided into the following price periods: January 1st-March 31st, April 1st-June 30th, July 1st -September 30th and October 1st-December 31st. The Finnish Energy Authority (EA) is an administrative sector of the Ministry of Employment and the Economy.¹⁵³ To receive the tariff a third party verified production report needs to be sent to the EA at the latest 2 months after the end of the price period. If the average electricity price during a price period is below €30/MWh the tariff will be the target price subtracted by €30 plus the electricity price. The subsidy is not paid for electricity produced during hours at which the electricity price in the production region is below zero. Since the tariff was installed in 2011 the electricity price has never been below zero and neither has the 3-month average been below €30/MWh, the last time that happened was in 2007.¹⁵⁴ The tariff can be received for up to 12 years or until the amount of produced electricity reaches the limit stipulated in the approval decision. The tariff is fixed and will not be increase annually with inflation thus giving developers an incentive to act fast.¹⁵⁵

Due to the dependency of electricity price market the system is not a true feed-in tariff system. A true system would guarantee a fixed price; the Finnish system is called a dual contract system since one “contract” is due to the electricity price and the other due to the subsidy. Generally the system is called a feed-in tariff system and thus referred to that in the study.¹⁵⁶

¹⁵² (The Energy Authority, 2014b)

¹⁵³ (The Energy Authority, 2014a)

¹⁵⁴ (Nord Pool Spot, 2014b)

¹⁵⁵ (Ministry of Justice, 2010a)

¹⁵⁶ (Stormoen, 2014)

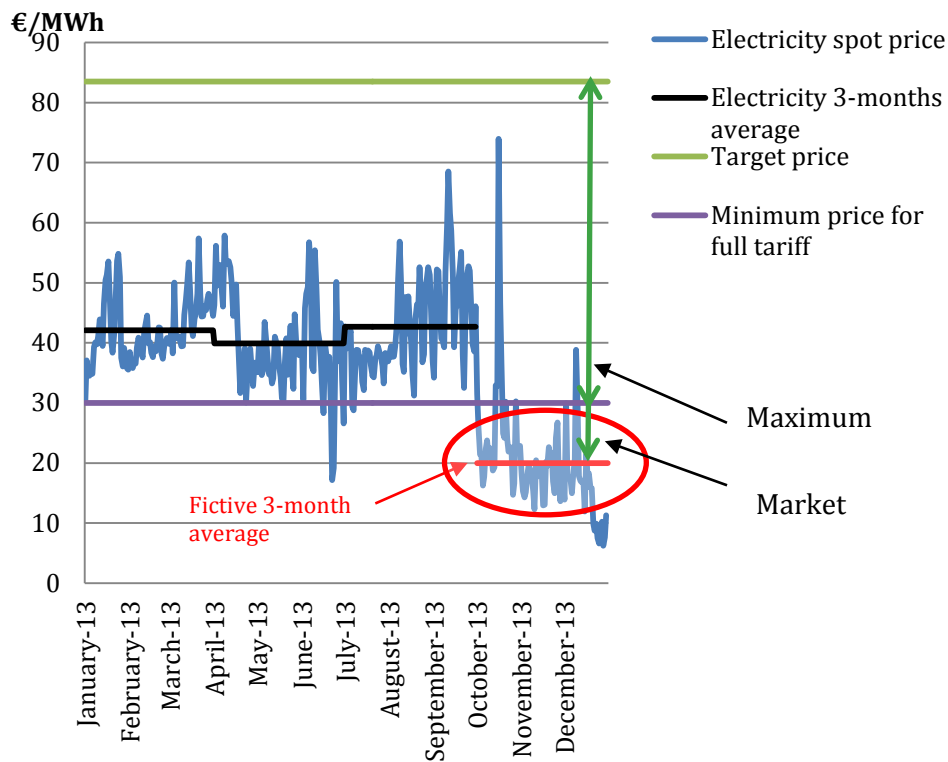


Figure 18: The FIT described with Finnish electricity prices from 2013

Wind power plants have an increased target price of € 105.30 for a maximum of 3 years until December 31st 2015¹⁵⁷.

5.1.4.1.4.1 Conditions for acceptance in the system

New wind power plants will be included in the system until the nominal effect of the total national wind power installation reaches 2500 MVA. To have the possibility of being included in the system a wind turbine needs to be located in Finland or on Finnish territorial water and connected to the power grid and the producer needs to have organizational and economical qualifications of power production. A wind power plant can be accepted in the system if: it is not receiving federal support, it is new and does not contain used parts, and the total nominal effect of the generators is at least 500 kVA¹⁵⁸. Filing an advance notification with the EA at the latest 1 month after the decision to build a wind power plant is made is an absolute requirement for acceptance in

¹⁵⁷ (The Energy Authority, 2014c)

¹⁵⁸ (Ministry of Justice, 2010a)

the system. The approval application must be filed through the SATU online system before commercial operation of a wind power plant begins.¹⁵⁹

5.1.4.1.4.2 Application process¹⁶⁰

5.1.4.1.4.2.1 Advanced notification

As mentioned in the section above an advanced notification must be sent to the EA at the latest 1 month after the decision to build a power plant that fulfils the requirements of the subsidy system. The application should include the following:

- The generators total nominal effect.
- Planned start date of commercial operation.
- A credible calculation of the power plants annual production.

5.1.4.1.4.2.2 Application

Electricity producers apply to the EA for acceptance in the system before the power plant is in commercial operation. The application should include:

- The start date for commercial operation
- A verification from a controller showing:
 - That the power plant and grid connection is on Finnish territory or territorial water and that the producer has organization and economical qualifications of power production.
 - That the wind turbine is new and does not contain second hand parts and that the nominal effect of the generators is greater than 500 kVA.
 - A detailed calculation of the power plants annual production.

5.1.4.1.4.2.3 Approval decision

5.1.4.1.4.2.3.1 Preliminary decision

A preliminary approval decision on the electricity producer's organizational and economical qualifications of power production as well as the positioning of the power plant and grid connection on Finnish territory can be given. Such a decision will be in effect for a fixed period of time up to 2 years.

¹⁵⁹ (The Energy Authority, 2014d)

¹⁶⁰ (Ministry of Justice, 2010a; Ministry of Justice, 2010b)

5.1.4.1.4.2.3.2 Final decision

As a preliminary application and an application containing all the required information and showing that the qualification requirements for inclusion in the system are met, an approval decision will be made.

The decision will include the following information and regulations for:

- The power plant and the total nominal effect of the generators
- The type of production support that will be applied.
- The total electricity production for which the feed-in tariff will be paid during the period for which the decision is in effect.

The right to the subsidy comes into effect the price period after the approval of the decision.

The decision can be withdrawn: if the production at the facility has been cancelled for at least one year without interruption and that this is caused by the electricity producer, the operation has not be started within 5 years of the decision, the electricity producer has declared bankruptcy.

If long-term significant changes are made to the power plant the decision can be renewed for e.g. the total nominal effect of the generators or the limit of electricity production receiving the subsidy.

If the power plant is acquired by another electricity producer with the needed qualifications to run the operations the EA will transfer the decision to this producer.

5.1.4.1.5 The installed Finnish wind capacity

The total installed capacity included in the subsidy system is 375 MVA as of May 2014; the actors owning this capacity are listed in table 4 below. Figure 19 graphically displays the total installed capacity and the different types of actors owning it. As seen in both figures mentioned above, 141 MW of wind power not included in the subsidy system exists in Finland, giving a total installed capacity of 516 MW.

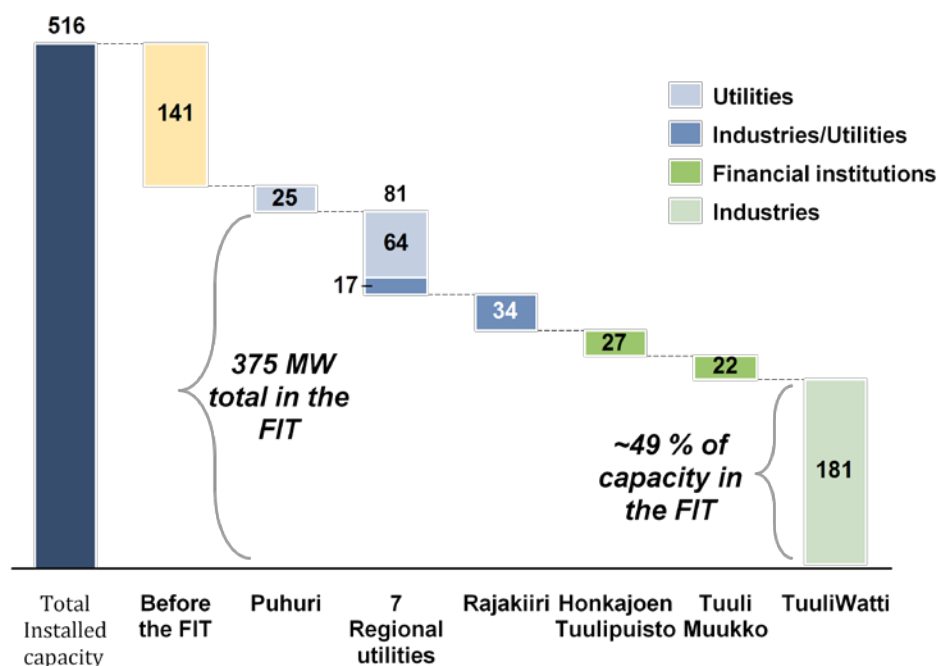


Figure 19: Total installed capacity as of May 2014 [MW]

The largest player in the feed-in tariff system is TuuliWatti Oy with an installed capacity of 184 MVA accounting for ~49 % of the total installed capacity. The company has and will continue to build industrial scale onshore wind parks in Finland¹⁶¹. 50 % of the company is owned by ST1 - a Nordic energy company focusing on energy with low carbon dioxide emissions. ST1 run a chain of gas stations in Finland, Sweden and Norway¹⁶². The other 50 % of the company is owned by S-Kanava - a Finnish conglomerate with grocery stores, retail, gas stations and tourism¹⁶³.

The second largest wind power electricity producer Rajakiiri Oy is owned by four Finnish industries and utilities¹⁶⁴. Honkajoen Tuulipuisto Ky has on farm but is in turn owned by Taalerithedas, a Finnish wealth management investor¹⁶⁵. The fourth largest player Puhuri Oy is owned by several smaller regional utilities with the purpose of building wind power to reduce carbon dioxide emissions on feasible sites with respect to the environment and

¹⁶¹ (TuuliWatti, 2014)

¹⁶² (ST1, 2014)

¹⁶³ (S-Kanava, 2014a; S-Kanava, 2014b)

¹⁶⁴ (Rajakiiri, 2014)

¹⁶⁵ (Taaleritehdas, 2013)

citizens.¹⁶⁶ A common way to organize wind power development is to put a park in a separate company which is owned by one or several companies. This is the case with TuuliMuukko Ky, owned by the developers TuuliSaimaa and TuuliTapiola Ky¹⁶⁷.

As of May 2014 only one solitary offshore turbine mounted on an isle is in operation in Finland.¹⁶⁸

Name of actor	Total installed capacity (MW)
TuuliWatti Oy	184
Rajakiiri Oy	34
Honkajoen Tuulipuisto Ky	27
Puhuri Oy	25
TuuliMuukko Ky	22
Innopower Oy	17
Oy Perhonjoki Ab	16
Haminan Energia Oy	15
Suomen Hyötytuuli Oy	10
Suomen Voima Oy	8,4
Raahen Tuulienergia Oy	7.7
Kotkan Energia Oy	4.7
Sumituuli Oy	2.1
Lumituuli Oy	0.9
Pettumäen Mylly Oy	0.7
Total	375

Table 4: Installed wind capacity in the FIT system as of May 2014¹⁶⁹

5.1.4.1.5.1 Actors on the Finnish market

¹⁶⁶ (Puhuri Oy, 2014)

¹⁶⁷ (Modern Utility Management, 2013)

¹⁶⁸ (Liukko, 2014b)

¹⁶⁹ (The Energy Authority, 2014g)

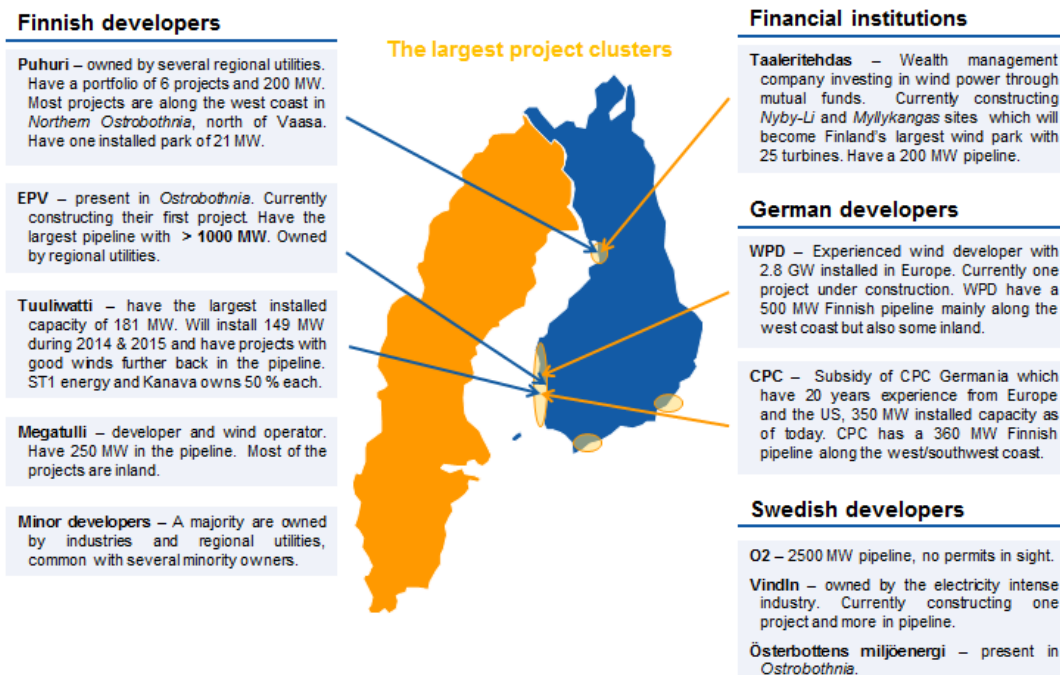


Figure 20: The largest actors and project clusters

5.1.4.1.6 Stakeholders¹⁷⁰

There are several different stakeholders in the wind power market. Most of them are shortly presented in the subsections below, and then further explained in chapter 5.2. The involved authorities and ministries are also introduced throughout the chapter 5.2. The grid operators are introduced later in the chapter.

5.1.4.1.6.1 Land owners

Business idea: to receive payment for allowing developers to build WTGs on or close to their properties.

The pieces of land are often quite small, thus a prospective wind park often affects many land owners. Initially the developers mainly concluded land leases with the land owners who would have a WTG on their property but this has changed as the expansion has taken place¹⁷¹. Today, all land owners within a radius of a WTG receives a weighted share of the disbursement from the wind park owner. The method is further explained in section 5.2.1.1.2.

¹⁷⁰ (Work document, 2014)

¹⁷¹ (Lundberg, 2014)

5.1.4.1.6.2 *Developers*

There are different kinds of wind power developers in the industry. The process of building one or many WTGs is long and costly. The study has categorized the developers into two kinds: those who manage a project until the construction permits are secure, and those who develop the projects from scratch and stay as owners over the generation as well.

5.1.4.1.6.2.1 *Permit developers*

Business idea: *to achieve permits and then sell them.*

There are small developers on the market that seek out potential areas to build wind farms at. They secure land leases and pursue all the necessary permits needed to construct the park. It is a time-consuming but less costly part of the life cycle. But a project with good wind resources could be worth a considerable amount of money even before construction¹⁷². At this time they sell the project to an actor who is to construct the farm and take the financial investment in the WTGs and surrounding works. This type of actor could be a land owner that has pursued the permits but lacks the competence and capital to build and run a wind farm.

5.1.4.1.6.2.2 *Wind developers*

Business idea: *to develop, build and manage a wind farm to collect earnings from selling generated electricity.*

The wind developers also seek out areas to build wind farms at, but without the intention to sell the park. They are able to carry the investment in the park and have a long pay-back time. There are both pure wind developers, but also large utilities like E.ON, Fortum and Vattenfall in this category.

5.1.4.1.6.2.2.1 *Findings from the developer survey*

A majority of the wind developers in Finland find it easy to attract the needed capital, even more so for large projects and projects at sites with high wind speeds. The most common form of financing is joint ventures with financial actors or utilities or bank loans. Both Finnish and international capital is used.

5.1.4.1.6.3 *Investors*

The yield of a wind farm is often quite low, but rather stable over a long period of time. It is also a clean energy source. There are mainly two types of investors interested in ownership of a park: financial and industrial investors.

¹⁷² (Stormoen, 2014)

5.1.4.1.6.3.1 *Financial investors*

Wind power is often a safe investment with a low but safe yield over a longer period of time. This is suitable for investors like insurance or asset management funds who are risk averse and are expected to make ethical and conscious investments. Finnish asset management fund Taalerithedas is among these and own projects under construction. The O&M during generation are often outsourced.

5.1.4.1.6.3.2 *Industrial investors*

Large companies (especially with high electricity consumption) have started to invest in renewable energy sources such as wind power. One of the reasons is to brand themselves as environmentally friendly, like for example IKEA or Google, when they only use renewable electricity in their production or stores.

5.1.4.1.6.4 *Consultants*

Some activities in the different project phases demand external experts to do deep investigations within a field. These experts are often used as consultants by the developers. There are also larger consultancy firms like Pöyry or Sweco who have specialized in wind power and even offer to lead a whole project from start to generation.¹⁷³

5.1.4.1.7 *The Finnish grid*

The EA ensures the functionality of the electricity and gas market, and overlooks the pricing of the network. It has a monopoly on issuing grid permits to actors whom want to start operating on the electricity network. The EA has given *Fingrid Abp* the overall system operator responsibility, thus making Fingrid the national grid operator in Finland¹⁷⁴.

The national grid is fractionised in three categories¹⁷⁵:

- The *main transmission grid*, which is operated by Fingrid, consists on high voltage networks (110 kV - 400 kV). The transmission system is designed as a meshed grid i.e. a single line failure does not limit power transmission to the customers¹⁷⁶.
- The *regional high voltage distribution networks* are operated by other stakeholders and are high-voltage networks of 110 kV. They are

¹⁷³ (Pöyry, 2014)

¹⁷⁴ (Finland's Ministry of Employment and the Economy, 2014)

¹⁷⁵ (Finnish Energy Industries, 2010)

¹⁷⁶ (Kuusela, 2014)

connected to the main grid radially, thus a radial network failure close to the main grid connection point affects the entire radial network from that point on¹⁷⁷. There are currently 12 different regional network owners in Finland¹⁷⁸.

- The *distribution networks* operate on 20, 10, 1 or 0.4 kV and are generally connected to a regional network but are occasionally connected directly onto the main grid. Distribution networks are also constructed like radio lines making them more vulnerable to damages. There are currently 82 different distribution network owners in Finland¹⁷⁹.

5.1.4.1.7.1 *Fingrid Abp*¹⁸⁰

Fingrid started operations in 1997 and has the state of Finland as majority shareholder (53.1 %). It is solely responsible for the high voltage transmission system (the backbone) in Finland. Electricity intense industry, large power plants and the regional distribution systems are all connected to Fingrid's grid. Fingrid's power transmission grid is illustrated in figure 21 below.

Fingrid is also involved in the work of ENTSO-E (the European Network of Transmission System Operators for Electricity), the umbrella organisation on European level for transmission system operators (TSOs). ENTSO-E's vision is to work for a secure and seamless European electricity market¹⁸¹.

Fingrid presented a ten year grid development plan in December 2012. One important focus point in the plan is to make necessary preparations for the connection of 2 500 MW wind power and two new nuclear reactors. A majority of the projects in the wind power pipeline are located along the Finnish coastline, which has led to both new transmission grids along the coast but also upgrades of 110 kV and 220 kV lines.

¹⁷⁷ (Kuusela, 2014)

¹⁷⁸ (The Energy Authority, 2014e)

¹⁷⁹ IBID

¹⁸⁰ (Fingrid, 2014b)

¹⁸¹ (ENTSO-E, 2013)

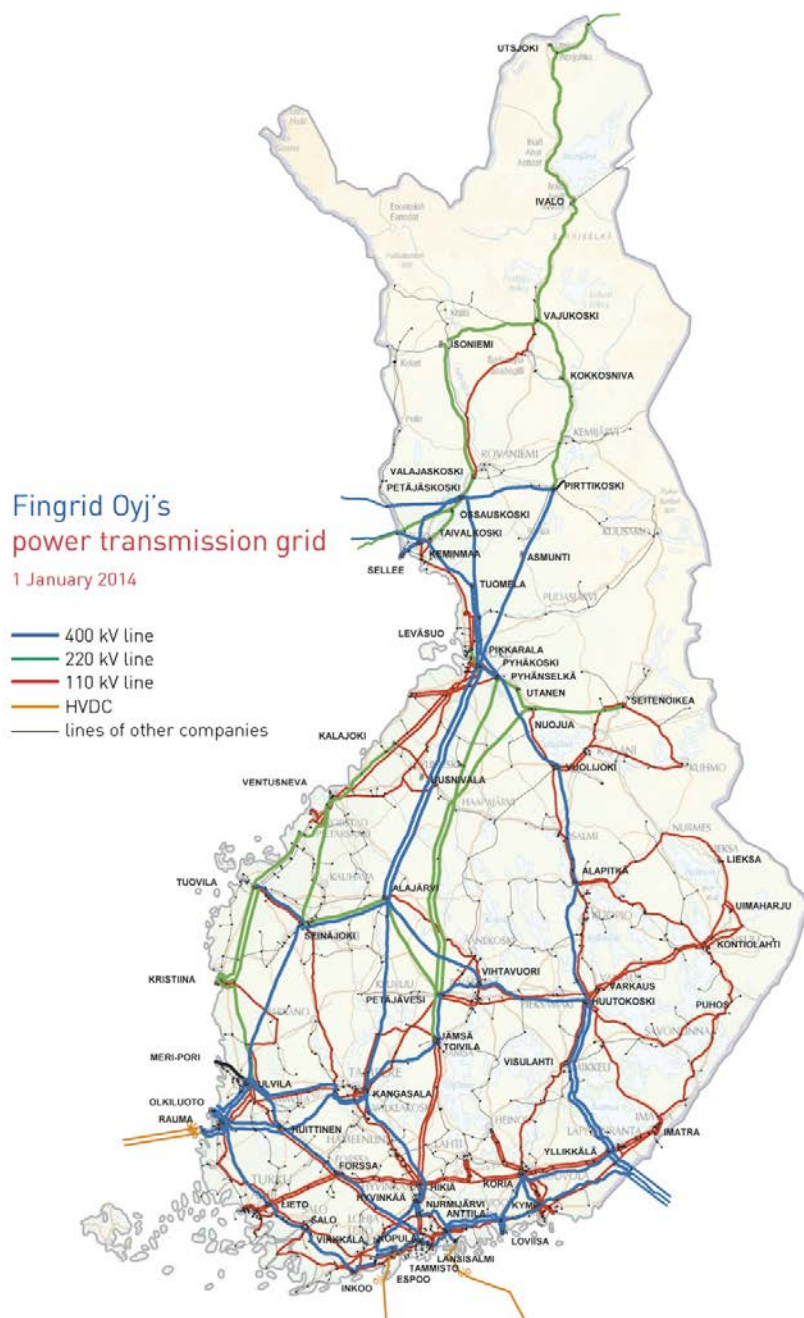


Figure 21: The Finnish main transmission grid¹⁸²

¹⁸² (Fingrid, 2014c)

5.1.4.1.8 The Finnish wind atlas and Finnish wind resources

The Finnish wind resources are best along the coast, especially off the southwest coast. The average geostrophic wind at 1000 meter altitude is 9-9.5 m/s which is stronger than in southern Europe but slightly weaker than northern Great Britain (10-12 m/s), the Norwegian coast 10-11 m/s, Denmark 10-10.5 m/s and similar to Sweden 9-10.5 m/s. The annual average wind at 100 m altitude offshore can be as high as 8.5-9.5 m/s in areas with good resources¹⁸³. Close to the coast in wind prone areas the wind speed can be 8.5 m/s at 100 m altitude, it decreases towards the inland.¹⁸⁴. Seasonal variations exist with stronger winds during the winter. The most dominant wind direction is southwest¹⁸⁵. Looking through the project pipeline a majority of the projects have an average wind speed of 6.5-7.1 m/s at 100 meters altitude and aim to build wind turbines with a hub height of 120-140 meters and a total height of 205-210 meters.¹⁸⁶

A wind atlas is constructed by the use of weather forecasting models and represents average wind conditions in an area, which will differ from the actual wind conditions in a certain geographical point¹⁸⁷. Wind developers use wind atlases to get a general idea about the wind conditions in an area and to identify potential sites. Once a site is selected, measurements of the actual wind at the site are always performed.

The Finnish Wind Atlas is an important tool for estimating the country's wind energy potential and it was published in 2009¹⁸⁸. The reference period was chosen from 1989-2007 since during this time no significant changes in the wind climate over Finland occurred¹⁸⁹. Due to the limit of computer power not all the months during the reference period could be used. Instead data was collected from 72 months of which 48 are considered to be average wind months; 12 months represent above average wind conditions and the last 12 months below average wind conditions. The atlas has a general 2.5 km²

¹⁸³ (Finnish Wind Atlas, 2009a)

¹⁸⁴ (Finnish Wind Atlas, 2009b)

¹⁸⁵ (Finnish Wind Atlas, 2009a)

¹⁸⁶ (Mikkonen, 2013)

¹⁸⁷ (Finnish Wind Atlas, 2009c)

¹⁸⁸ IBID

¹⁸⁹ (Finnish Wind Atlas, 2009d)

resolution but selected areas have been zoomed in to the greater resolution of 0.25 km².¹⁹⁰

Due to the northern location of Finland icing can occur on wind turbines. Three main problems are related to icing: aggregation of ice on the rotor blades causing production loss, the icing also increases the stress on parts thus shortening their life time and if the cup-anemometer is iced and cannot measure the wind speed the turbine needs to be stopped to avoid controlling errors. All of the above affects the potential incomes and costs and thus icing needs to be considered when planning a wind park. Therefore an icing map for Finland has been developed by modelling temperature, liquid water content and wind speed¹⁹¹. Icing especially occurs in the northern inlands but to a smaller extent on the northwest coast and the south coast.¹⁹²

The atlas has an interactive interface with the possibility of selecting monthly and annually wind speeds and power production with the 2.5 km² and 0.25 km² resolutions for various heights. A production loss estimate due to icing is also included¹⁹³. It also contains fixed maps with annually monthly average wind speeds (m/s) and estimations of the electricity generation from a 3 MW wind turbine both at 50, 100 and 200 meters above sea level¹⁹⁴.

¹⁹⁰ (Finnish Wind Atlas, 2009c)

¹⁹¹ (Finnish Wind Atlas, 2009e)

¹⁹² (Finnish Wind Atlas, 2009b)

¹⁹³ IBID

¹⁹⁴ (Finnish Wind Atlas, 2009f)

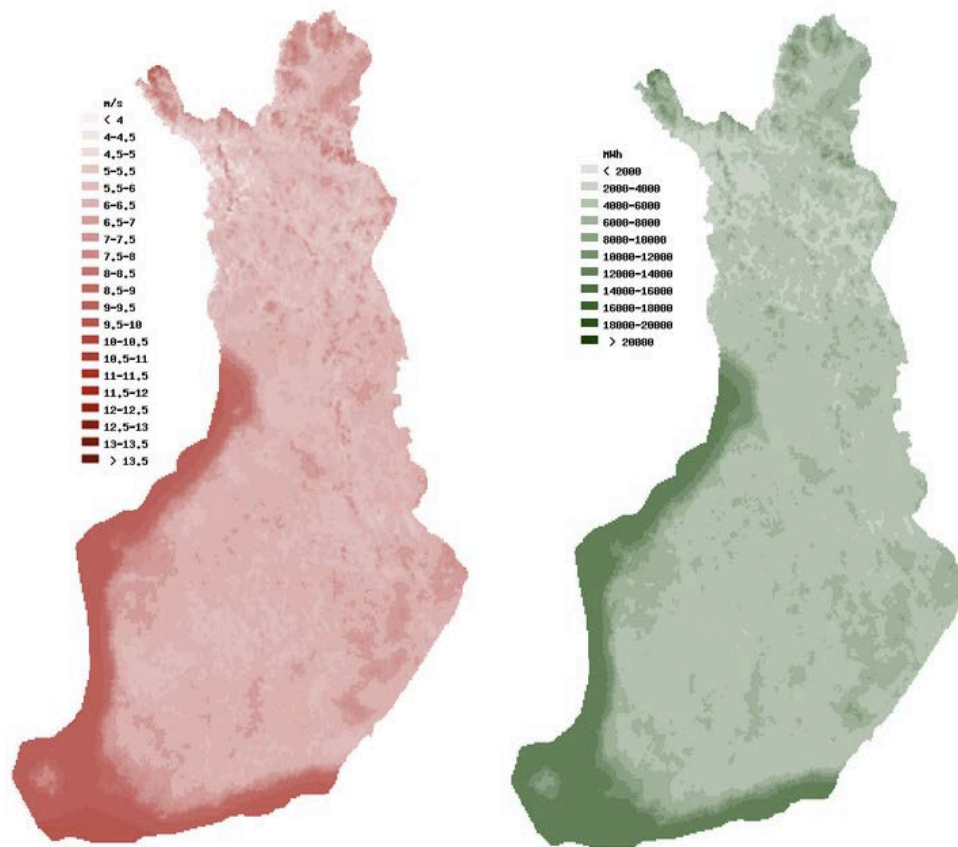


Figure 22: To the left: Annual average wind speed (m/s) at 100 m¹⁹⁵
 To the right: Annual average electricity production (MWh) at 100 m¹⁹⁶

5.1.4.2 Future

5.1.4.2.1 The project pipeline

As mentioned in section 5.1.4.1.4.2.1 an advanced notification needs to be submitted to the EA at least one month after the construction decision has been made. For projects starting operations in 2014; advanced notification for 272 MVA have been submitted. For projects starting operations in 2015 the number is 238 MVA. The largest wind developer installing new capacity in both 2014 and 2015 is TuuliWatti, installing 149 MVA over the two years, giving them a total installed capacity of 333 MVA by the end of 2015. Puhuri Oy with existing capacity will build 43 MVA. Other larger developers with

¹⁹⁵ (Finnish Wind Atlas, 2009c)

¹⁹⁶ (Finnish Wind Atlas, 2009f)

advanced notifications are EPV Tuulivoima Oy with 56 MVA and Taaleritehdas building the park Myllykankaan Tuulipuisto with 56 MVA.^{197 198}

As of May 2014 by the end of 2015 the total installed wind power capacity in Finland seems to be 885 MVA leaving 1615 MVA still available in the feed-in tariff system, a graphic display of the project pipeline until the end of 2015 is found in figure 23. For that remaining capacity Finland has a pipeline of 8000 MW onshore and 3000 MW offshore.¹⁹⁹

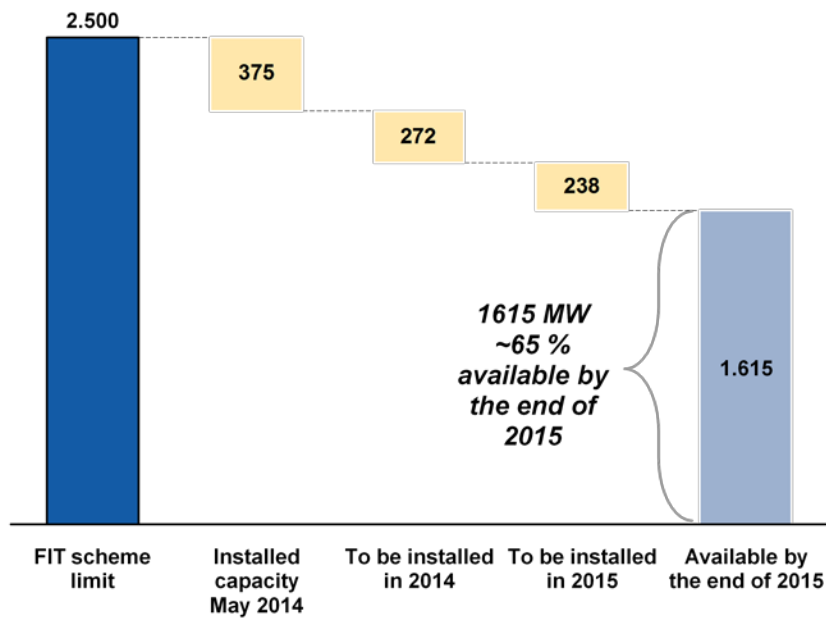


Figure 23: The project pipeline up until 2015

The pipeline after 2015 starting with those nearest to completion follows below.

Project phase	Capacity (MW)
Preparing for construction	116
Applying for permits	448
EIA approved	106
Under planning	2100

Table 5: Project pipeline after 2015

¹⁹⁷ (The Energy Authority, 2014g)

¹⁹⁸ (The Energy Authority, 2014h)

¹⁹⁹ (The Finnish Windpower Association, 2013)

All of these sum up to 2770 MW, in these earlier phases it is harder to estimate how big the final capacity will be since that is decided in the building permit and the developers need to suggest two alternative layouts in the EIA²⁰⁰. Nevertheless a majority of the projects are most likely the ones that will fill up the feed-in tariff system. Developers with large capacity in the pipeline are for example; CPC Finland, EPV Tuulivoima Oy, Ilmatar Windpower Oyj, Intercon Energy Oy, Megatuuli Oy. EPV Tuulivoima Oy is the largest actor with up to 1000 MW in its pipeline and CPC Finland is the second largest with approximately 400 MW for these phases.²⁰¹

Officials and wind developers believe that the growth to 2500 MVA will come from onshore. For the potential further growth after that it is estimated that it offshore will play an important part²⁰². Others claim that Finland will not be full of wind turbines by then and since offshore has a cost disadvantage it will not be profitable in a technology neutral system such as the current one²⁰³.

5.1.4.2.2 The feed-in tariff subsidy

As described in above, today a developer needs to send in an advanced notification at the latest one month after a construction decision has been made. Today the developers will not get a final decision on whether they will be included in the system or not until their wind turbines are in operation. Both of these conditions will change by replacement of the advanced notification by a “quota decision” ensuring inclusion in the system. The requirements for such a decision will be a building permit and grid connection agreement, the decision will be valid for 2 years and related to a specific wind project and transferable. The “Quota decision” will be in effect from June 2014.²⁰⁴

The Finnish wind power association believe that the system will be full by 2019-2020.²⁰⁵ Looking at the Swedish wind power development it took 7-8 years to increase from 0-6 TWh and thus it is reasonable that the system will be full by 2018-2019.²⁰⁶

²⁰⁰ (Yli-Teevahainen, 2013)

²⁰¹ (The Finnish Windpower Association, 2013)

²⁰² (Liukko, 2014a)

²⁰³ (Stormoen, 2014)

²⁰⁴ (Liukko, 2014b)

²⁰⁵ (Suominen, 2014)

²⁰⁶ (Stormoen, 2014)

5.1.4.2.2.1 Future subsidy scheme

The current feed-in tariff system is expected to have met its quota by at the latest 2020, thus the wind power electricity generation should be approximately 6 TWh annually. There is however no clear path how to reach the target of 9 TWh by 2025. Developers have high hopes of a new, equally beneficial subsidy scheme. The current government acknowledges that there will be a need for a new scheme, but are hesitant to indicate what it might be, claiming that it will be up to the new government to decide after the 2015 election²⁰⁷. Sources inside the responsible department admit that there are early discussions about the subject, but that no decisions will be made in a few years. There are speculations that the growth from 6 to 9 TWh will take place offshore as there will be few viable onshore sites left, indicating that another subsidy scheme will be needed.²⁰⁸

5.1.4.2.3 The grid

The both new and upgraded transmission link along the west coast is under construction and supposed to be fully operational by 2016. Fingrid's development plan of the grid from 2012 includes:

# of substations / length of transmission lines	Beginning of 2012	End of 2022	Net change
400 kV substation	39	53	14
400 kV power lines	4549 km	6300 km	1541 km
220 kV substation	19	10	-9
220 kV power lines	2568 km	1215 km	-1353 km
110 kV substation	55	65	10
110 kV power lines	7505 km	7982 km	477 km
Σ substations	113	128	15
Σ power lines	14622 km	15497 km	875 km

Table 6: Fingrid's grid development plan 2012-2022²⁰⁹

As seen in table 6 above, almost half of all the 220 kV power lines are to be either operated at 110 kV or 400 kV. Also, the targets above should be able to handle both 2500 MVA wind power and two more nuclear reactors. There will be no significant bottlenecks in the transmission grid after 2016 when major grid development projects are finalized in western Finland.²¹⁰

²⁰⁷ (Niinistö, 2014)

²⁰⁸ (Liukko, 2014a)

²⁰⁹ (Fingrid, 2013)

²¹⁰ (Kuusela, 2014)

The autonomous island Åland between Sweden and Finland is to be further connected to the Finnish grid. Kraftnät Åland is building the transmission line which is to be operational in 2015 and will increase the transmission capacity between Finland and Sweden with a maximum of 80 MW²¹¹. There has been discussion about inclusion, but for now wind power parks connected to Åland are not allowed in the feed-in tariff system²¹².

5.1.4.3 Risks

Jan Lundberg has experienced issues with settling the grid connection with the grid operators. Even though the operators are bound by law to allow connection to the grid, there may be hiccups, especially in regions with many projects or grid owner who also develops wind power. Connecting wind power to the grid causes difficulties in coordinating good connection points and also creates a need of balance power when the wind strength is low. Even though the developer takes all the cost for needed lines, substations etc, the hassle makes some grid owners less accommodating. Even more so when the operator itself are developing projects in the region.²¹³

5.1.4.3.1 Findings from the developer survey

The survey conducted among wind developers in Finland showed that most of them consider the following to be the largest business risks; the delay of the EU 2030-targets, decrease of the feed-in tariff as happened in Spain and that there will not be a succeeding subsidy system.

5.1.4.3.2 The feed-in tariff subsidy

Changes in the EU regulation for state aid might decrease the allowed state aid and thus the feed-in premium. Such a change is believed to come into effect by the end of this decade, if it happens at all.²¹⁴

In the approval decision a developer receives the maximum amount of MWh for which he can receive the tariff during the 12 years period. After a few years of operations with more reliable numbers on the actual production a wind power owner might realise that the total electricity production during 12 years will likely exceed the maximum in the approval decision. The owner can then apply for a new higher maximum amount of MWh, that possibility

²¹¹ (Fingrid, 2013)

²¹² (Kuusela, 2014)

²¹³ (Lundberg, 2014)

²¹⁴ (Liukko, 2014a)

might be changed as more wind turbines are included in the system and the total cost rises.²¹⁵

Retroactive changes have happened in Spain causing wind power investors big financial burdens as they had to repay some of the subsidy that they have received. The risk for such a change in Finland is believed to be small.²¹⁶

5.2 The Finnish onshore wind power life cycle

This chapter describes all the steps in the process of building an onshore wind park in Finland. The focus is on onshore wind power since that is currently being built on a large scale.

The life cycle process is more complex and requires more investigations for larger wind parks compared to smaller parks or solitary wind turbines. The process described below is for wind parks exceeding 10 wind turbines or with a total effect of more than 30 MW, and from a perspective of a developer whom intend to own the farm long-term.²¹⁷ For wind parks smaller than this the regional ELY-centre (Centre for Economic development, transportation and the environment which is the responsible authority)²¹⁸, can decided that an EIA is needed if the project will have a large environmental impact or if many other project with environmental impacts are planned in the area. The CL²-framework applied and adjusted onto the wind power market in Finland is shown in figure 24 below.

²¹⁵ (Tenhovirta, 2014)

²¹⁶ (Paalatie, 2014; Tenhovirta, 2014; Becker, 2014)

²¹⁷ (Ministry of Justice, 2006)

²¹⁸ (Centre for Economic Development, Transport and the Environment, 2014)

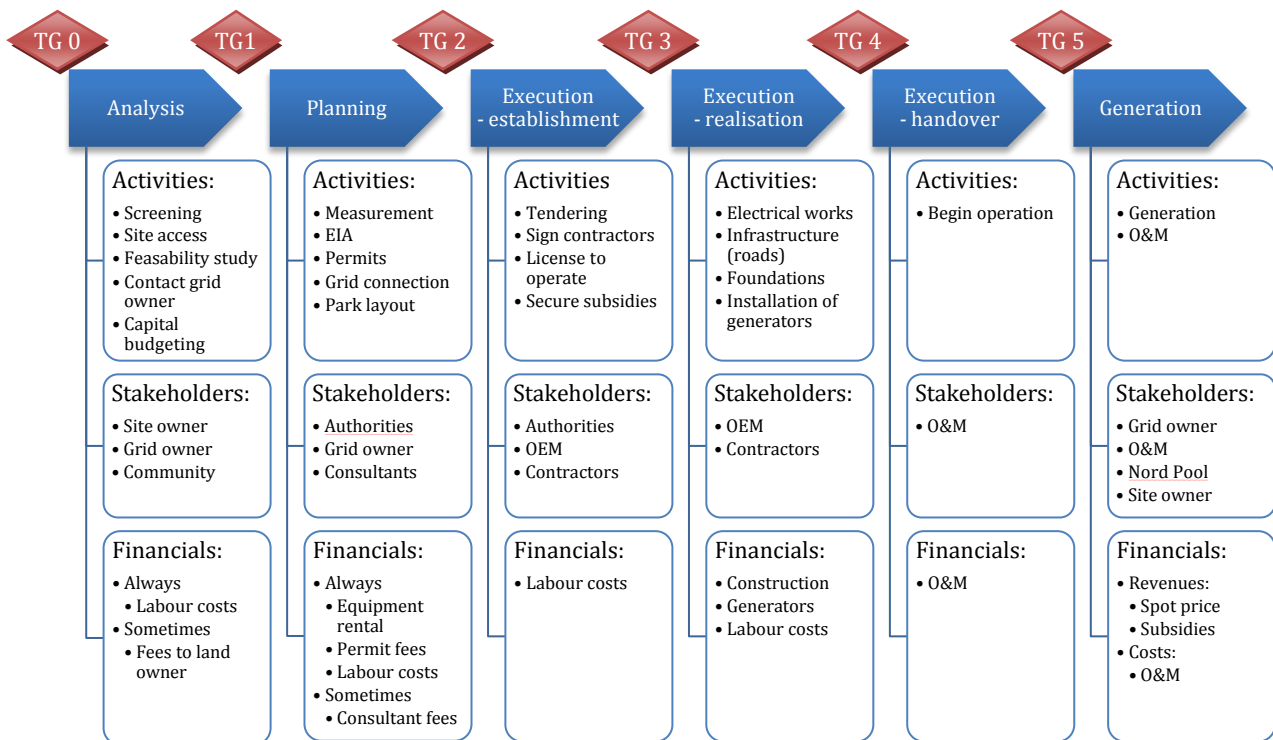


Figure 24: The project life cycle of onshore wind power in Finland

5.2.1 Analysis

The purpose of the analysis is to find and evaluate sites that show potential for wind power development. The first step is to screen and quickly evaluate many sites. When an interesting site is found the phase moves on to ensuring site access through a contract or a land lease. During the analysis contact with the grid owner is established to start the planning of the grid connection. A feasibility study is also conducted to quickly analyse all needed aspects. Finally the first capital budgeting calculations are done to check the economic viability and potential of the project.

5.2.1.1 Activities

5.2.1.1.1 Screening

The purpose of the screening is to find and quickly evaluate areas that seem to have favourable conditions for wind power development. Some of the factors that are included in the first evaluation are: land ownership, wind resources, the electricity grid and nature reserves. The potential for wind power is

estimated and quantified in number of wind turbines, electrical and economic output.²¹⁹

Approximately one out of three projects survives the analysis phase and passes TG1.²²⁰

5.2.1.1.2 Site access and land lease

When an interesting site is found the affected land owners are contacted. If the owner is interested in wind power development on his land, a land lease is established between the developer and the land owner. The lease gives the developer access to the land for detailed investigations, planning, construction and operations. The usual length of a lease is 35 years. A land owner usually starts receiving the lease payment after the turbine is in operation.²²¹

The payment can be fixed or flexible; the flexible alternative is most frequently used. A fixed payment pays a fixed annual fee for a predetermined number of years. A flexible payment is often a percentage of the annual electricity production and incomes is paid once annually in arrears. If the area is divided into several properties each property received a lease in accordance to its part of the total wind power area, the land under the airspace that a turbine uses.²²²

In the beginning of wind development in Sweden, developers signed contracts only with the land owner owning the land where the turbine was to be situated. The aim was to only pay rent to that property owner. As a turbine on a neighbouring property would take away the possibility of building a turbine for the neighbours without giving them any compensation, they would appeal and try to stop the project. Many projects were stopped and developers realised the need for another model compensating several of the surrounding property owners.²²³ An example of such a model is described in the next paragraph.

An example of a lease model used in Finland is the one used by the wind developer O2. It also gives reimbursement for existing roads, new roads, cable ditch, hardstand, and switch gear. Land owners are assigned portions per hectare land, per wind turbine, per meter road and ditch and per square meter

²¹⁹ (O2, 2013a)

²²⁰ (Work document, 2014)

²²¹ (O2, 2013b)

²²² IBID

²²³ (Lundberg, 2014)

hardstand and switch gear. The incomes from the turbines are divided by the total number of portions, and then the land owners are reimbursed for their number of portions. The total annual reimbursement is 4 % of the incomes which ranges from €500 000 - €700 000/turbine during the first 12 years. The income the following years is without the feed-in tariff and depends on the future electricity price.²²⁴

5.2.1.1.3 Feasibility study

When assessing the feasibility for wind turbines in an area many factors are taken into account. The technical and economically feasibility results from the wind resources, the distance to and the transmission capacity of the electrical grid and the area's infrastructure. Wind turbines negative effects on the landscape, wildlife and the human living environment are also taken into account. This study also shows which more in-depth studies that are needed to fully understand the impact of a wind park on the wildlife at the site as well as the surrounding environment and inhabitants. The need for in-depth studies can also be pointed out in the EIA which is conducted in a latter planning phase. The phase during which all in-depth usually are conducted.²²⁵

5.2.1.1.4 Contacting the grid owner

Wind developers are advised to contact the grid owner early in the project. Together they conduct a grid investigation based on the conditions of the project. The investigation results in suggested connection points, improvements suggestions of the existing grid if necessary and a time schedule.²²⁶

5.2.1.1.5 Initial profitability calculation

Estimates on the costs of wind development are known to developers and they are used together with the wind resource estimates from the wind atlas to check the economic viability of the project with capital budgeting.²²⁷

5.2.1.2 Stakeholders

5.2.1.2.1 Land owner

Land owners who will benefit from the park by receiving income are usually positive to wind development while the neighbouring property owners who

²²⁴ (O2, 2013c)

²²⁵ (Work document, 2014)

²²⁶ (Ministry of the environment, 2012)

²²⁷ (Work document, 2014)

will not benefit usually have a more negative mind set. The neighbours might have been interested in wind development but since the turbines need a certain distance to each other that possibility might be cancelled by nearby development. Neighbours with properties next to wind parks might feel that the value of their property decreases due to the noise, visual and shadow disturbance from the park. ²²⁸

5.2.1.2.2 Grid owner

According to the Electricity market act the grid owners are required to connect new electricity production if it fulfils the needed technical specifications. The grid owners are allowed to charge the owner of the productions facility a reasonable fee for the connection²²⁹. As written above the connection of a new wind park can sometimes cause a need for investments in the grid. Even though the grid owners are required by law to ensure a connection the need for investment can decrease their interest in the project and thus slow the response time.

The developer has to pay for new transformers at the connection point to the external grid but they become the property of the grid owner who is responsible for its operation and maintenance.²³⁰

5.2.1.3 Financial

No incomes are generated during this phase. Costs that occur during this phase are especially labour costs of personal working with screening, feasibility studies, contact with the grid owner and negotiations with land owners. Fees can also be paid to land owners for access to their property. The total cost of this phase is approximately < €0.27k and is approximately the same for projects in various sizes²³¹. As a proportion of the total the costs of this phase are small.

5.2.1.4 Future

The improvement potential for this phase is limited but as wind developers becomes more experience they improve their evaluation process and thus become faster and better at finding the sites with big potential. In a young wind market like Finland the best sites are developed first. As the market matures sites with smaller wind resources are investigated. At such sites the

²²⁸ (Lundberg, 2011)

²²⁹ (Ministry of the environment, 2012)

²³⁰ (Stormoen, 2014)

²³¹ (Work document, 2014)

safety margin between a successful and unsuccessful investment is smaller and thus the first processes in the analysis phase needs to be more reliable.²³²

5.2.1.5 Risks

The biggest risks in this phase are: not getting access to the site and that the feasibility study shows many potential wild life or environmental impacts that need further in-depth studies.

5.2.2 Planning²³³

In this second phase all activities and investigations are more detailed and in-depth. During this phase a first draft of the park layout is made which together with more accurate wind data from onsite measurements improves the accuracy of the economic prognoses. The purpose of this phase is also to conduct the EIA and acquire all needed permits and finally the construction permit.

5.2.2.1 Planning of land

Before a developer can receive a construction permit the area intended for a wind park needs to be plan in one of the area plans described in the following paragraphs. Under certain circumstances also described below an exemption can be made.

The following plans exist;

- Regional plan – suitable areas for wind power usually with 8-10 turbines. Limitations on height and number of turbines can be included.
- General plan – can be used as a basis for building permit for wind power, mostly in rural areas.
- Detail plan – is a general basis for building permit. Used for wind power close to towns.

The planning of areas suitable for wind parks is a process in several steps in accordance with the Land use and building act and its complementing bylaw. The planning start from overhead with the *National goals for land use* among others concerning energy supply and transmission, the goals are concretized in the regional plans, general plans and detail plans. Landscape councils develop regional plans and the general and detail plans are the responsibility

²³² (Lundberg, 2014)

²³³ (Ministry of the environment, 2012)

of the municipalities. The overhead plans are guidance for the more detailed plans.

In the regional plans areas suitable for wind power development are specified with a number of turbines. The number varies with the region but is usually 8-10 turbines or greater. When limitations exist they are specified for example; as the exact number of turbines, their height and position. The regional plan shows the areas for high-tension lines over 110 kV. Suitable connection points for wind power parks to the grid are also shown when known. Wind power development with regional significance is only possible when planned in the regional plan. Historically the regional plans have only planned wind power in the sea, coastal and northern mountain areas. In 2008 this changed and the plans are now to include wind power development in all types of areas. Areas designated for wind power in the regional plans are rough estimates and still need further investigations and planning.²³⁴

The general plans guide the land use and control the detail planning in municipalities. Due to a legal change in effect since 2011 general plans directly controlling the development of wind power can be used as a basis for building permits for wind power instead of the detail plan. It is allowed in situations with no need to coordinate the development of wind power with other land use in need of detailed planning. It is also necessary that the planning area is big enough in comparison with the wind park and that the consequences of the wind park can be determined in enough detail. This practice is most common in rural areas or offshore.

A detail plan is developed when the need for coordination between the development of wind power and the surrounding land use so requires. The detail plan focuses on a healthy, safe and joyful living environment. Therefore when wind power is planned in a detailed plan it focuses on: disturbing noise, safety, the landscape and recreation. The detail plan is the basis for building permits and therefore the plan needs to include the dimensions of the turbine and the technical solution for service and electricity transmission. If the development of a general plan or a detailed plan is due to initiative of a wind developer with interest in the area then the developer might be charged a part of or the total cost of the plan. Detailed plans are usually used for planning of wind power in areas close to towns or in industrial or port areas.

²³⁴ (Paalatie, 2014)

A wind developer can plan a wind park in an area, which has been planned for wind development in a general plan or a master plan. The general plan is used in rural areas and the detail plan close to residential areas or in industrial areas. If a developer finds an area suitable for wind development, which has not yet been planned, the developer can request that the regional council or municipality establish the required plan, in this case the developer might have to pay some of or the total cost of the plan.

5.2.2.1.1 Decision on exception from the planning need

If a project is found to only have smaller consequences for the surrounding environment the project owner can apply for a decision on exception from the planning need at the municipality. When such a decision is made it is the basis for the construction permit.

5.2.2.2 Activities

5.2.2.2.1 Wind measurements

The Finnish wind atlas can be used as a first estimation of a site's wind resources. When a wind developer has gained access to a site through a lease the actual wind speed and direction is measured to improve the production estimates and determine the possible positions of the turbines.

The traditional way of conducting wind measurements is with a mast with a height of 100 meters and sensors at several levels, measuring wind speed and direction.²³⁵

Wind measurements can also be done with a SODAR-system (SOund Detection And Ranging). The system placed on the ground sends up a sound wave as an acoustic pulse and analyses the returning signal's strength and frequency. The SODAR-system calculates the wind speed, wind direction and character of the air currents. The wind speed is measured at 60, 80, 100, 120 and 200 meters altitude. A SODAR-system can be rented in Finland for € 5200/month. Owning a system is estimated to cost €25 000 annually²³⁶.

Wind measurements are usually conducted for one year and are used to make a prognosis for the winds during the wind turbines lifetime of 20-25 years. Winds vary on annum; a good year can have 30 % higher monthly average wind speeds and a bad year 30 % lower wind speeds compared to a normal

²³⁵ (Vindkraftsnyheter.se, 2011)

²³⁶ (Skog, 2011)

year²³⁷. To create long-term prognoses the wind data is therefore recalculated to a normal year²³⁸.

5.2.2.2.2 Environmental impact assessment - EIA²³⁹

According to the EIA law an EIA is to be conducted for projects with large negative environmental effects. The purpose is to decrease and prevent negative environmental consequences by clarifying them already in the planning phase, to increase the amount of information available to the citizens and allow them to comment on the project. An EIA is required for a wind project when the number of turbines exceeds 10 or the total effect is greater than 30 MW, the construction facilities needed for the project such as roads and power lines are also included in the EIA. Projects that are smaller than the size above can apply for an exemption of the EIA. If a project due to its character and size or the total effects of several projects in an area is believed to be substantial an EIA can be needed also for smaller projects.

An EIA investigates the environmental consequences during the lifecycle of a wind park especially for:

- “Land use and built environment.
- Landscape and the cultural environment.
- Human living conditions, satisfaction and safety (especially noise and flashing effects).
- Natural values (especially bird populations).
- Traffic (especially aviation).
- Industries (agriculture, forestry, fishing, reindeer husbandry, tourism etc).
- Defence operations.
- Radar systems and data communication.”²⁴⁰

The EIA can be divided into two phases. The process is started when the project owner sends the assessment program to the ELY²⁴¹. The assessment program includes alternative implementations for the project usually with varying numbers of WTG and total effect, consequences for investigation during the planning, how the assessment will be conducted and how the

²³⁷ (Finnish Wind Atlas, 2009g)

²³⁸ (Wizelius, 2002)

²³⁹ (Ministry of the environment, 2012)

²⁴⁰ IBID

²⁴¹ (Centre for Economic Development, Transport and the Environment, 2014)

stakeholder will be involved²⁴². The ELY examines the assessment programs and states if further investigations are needed. In the second phase the project owner develops an impact description, when finalized the ELY gives its statement on the impact description and its sufficiency. Without delays the first part takes a maximum of 30 days to handle by the ELY and the second one 60 days.²⁴³

The project owner, a citizen, a citizen organisation, another authority or ELY itself can require the ELY to assess the need for an EIA. The decision will be made at latest 1 month after the ELY has received all the need information. If a project has been planned in a regional or a detailed plan and the planning process has examined the consequences of the project, made enough information available and involved the stakeholders there might not be a need for an EIA.

One principle in the EIA law is that the EIA assessment and the planning process should be coordinated. All investigations required by both processes should be conducted at the same time and in a thoroughly way to fulfil both EIA and planning requirements.

5.2.2.2.3 Laws affecting wind power development²⁴⁴

Depending on the area in which wind power is developed or its surrounding, permits in accordance with various laws might be needed.

5.2.2.2.3.1 *The nature conservation act*

The purpose of the nature conservation act is to protect nature's diversity, beauty and value of the landscape. Development of wind power might be affected by the rules of nature reserve found in the third chapter. The Natura 2000 network consists of areas which the EU considers to be valuable for preservation of living environments, wild life, plants and bird protection areas. When wind power is develop in or close to such an area a special investigation on the effects of the area is to be conducted.

5.2.2.2.3.2 *The environmental protection act*

Wind power projects require an environmental permit if the operation of the turbines causes brute noise or flashing disturbing neighbours. According to the environmental protection act the landscape layout effects do not require

²⁴² (Yli-Teevahainen, 2013)

²⁴³ (Paalatie, 2014)

²⁴⁴ (Ministry of the environment, 2012)

such a permit. The law also prohibits pollution of land, groundwater and the sea, which a wind project needs to take into account.

5.2.2.2.3.3 The water act

A wind project requires water permits from the water act if it might change something about a watercourse, the beach or the groundwater. The permit is applied for at the regional state administrative agencies (AVI). If the permit is needed for a project also needing an EIA the description of the consequences and permit application can be included in that process. Wind power plants cannot be built in fairways or anchoring zones.

5.2.2.2.3.4 The aviation act

The construction of wind turbines in general needs an aviation interference permit. The aviation act requires a permit from the traffic safety authority for all constructions taller than 30 meters close to airports or taller than 60 meters elsewhere. The constructions must not disturb the aviation, its communication system or in any other way decrease its safety. A statement from Finavia the supplier of aviation communication needs to be attached to the permit application. The permit states the necessary marking, for daytime painting and for night time lighting.

5.2.2.2.3.5 The highway act and the railway track act

The highway act defines highways as all roads operated and maintained by the federal government. The free view and protection area is generally 20 meters from the middle line but can be decreased or extended up to 50 meters. If the road serves as a spare runway the free view area can be extended up to 300 meters on each sides and 750 m from each end of the runway. Along highways with a speed limit of 100 km/h the recommended distance for a wind turbine is 300 meters or at least the total height of the turbine plus the protection distance of 20-50 m.²⁴⁵

Similarly the free view and protection area along railway tracks defined in the railway track act is generally 20 meters but can be decreased or increased up to 50 meters. Within the protection areas defined in either law construction of wind turbines is prohibited.

5.2.2.2.3.6 The electrical market act

The grid owner shall on a request and for a reasonable fee connect electricity production within the area if the facility fulfils the technical specifications.

²⁴⁵ (Ministry of the environment, 2012)

Wind developers are advised to contact and negotiate with the grid owner early on. Wind parks with an effect exceeding 250 MW can be connected to the 400 kV grids. Parks with an effect of 100-250 MW are usual connected to the 110 kV but if the technical or economic conditions of that grid are poor, parks of that size can also be connected to the 400kV grid. To build a power line with 110 kV or higher voltage a permit from the EA is needed; an EIA is required in the application.

5.2.2.2.3.7 The redemption act

Power lines are realized through a redemption process in accordance with the redemption act. The project owner applies for a redemption permit from the cabinet minister, the permit is used to redeem a land use right and to define reimbursements for the land owner.

5.2.2.2.3.8 The defence act and the territorial surveillance act

Wind power development needs to – in accordance with the defence act and the territorial surveillance act - consider the armed forces need of bases, practice areas, military aviation, spare landing areas and surveillance systems. If a permit is needed it should be applied for at the military headquarters compound.

5.2.2.2.3.9 The ancient monument act

Set ancient monuments are protected by the ancient monument act. Planning or development requires an investigation and assessment on its effect on ancient monuments within the area if such exists.

5.2.2.2.3.10 The wilderness act

Wilderness areas –defined in the wilderness act - are created to preserve the wilderness and the Sami culture. Today 12 wilderness areas exist in Finland, all in Northern Lapland. These areas are not suitable for wind power development.

5.2.2.2.3.11 The reindeer husbandry act

The reindeer husbandry act gives reindeer husbandry the right to free grazing land in certain areas. When developing wind power in such areas one needs to consider its limitation, investigate the effects the wind power will have on the reindeer husbandry and negotiate with representatives from its organisations.

5.2.2.2.3.12 The Sami parliament and Skolt act

Sami and Skolt are indigenous populations living on reindeers in northern Finland. When developing wind power in Sami or Skolt areas the project

owner needs to negotiate with the Sami parliament or representatives from the Skolt community in accordance with the Sami parliament act and the Skolt act.

5.2.2.2.4 Construction permit application²⁴⁶

The general construction rules also apply to the construction of wind farms; a building permit is always needed. A municipality's construction regulatory authority approves construction permits. The application should include; a document stating the right to use the construction site, the buildings' blue prints, information on the applicants other planned neighbouring wind turbines, an investigation of the consequences for the landscape concerning the citizens, roads, recreation areas and the use of the neighbouring real estate. An aviation interference permit should always be attached, most of the time an EIA also needs to be attached, other permits such as; permits according to the water law and environmental permits are to be included when needed.

During the application process the neighbours are allowed to comment on the project. If the area has been reserved as: a recreation area, protection area or of importance to nature conservation in the region plan the regional ELY-centre will give a statement.

After the permit has been given there is an appeal period of 30 days after which the permit is irrevocable. An appeal is sent to an administrative court. If the appeal is turned down by the court the permit will become irrevocable. If the appeal is found relevant the court will return the permit application to the municipality.²⁴⁷

5.2.2.2.5 Park and grid connection layout

For two reasons, park and grid connection layouts are formalized during this phase. Firstly, as written above, alternative park layouts as well as the parks internal grid and its connection to the external grid are to be included in the EIA assessment program²⁴⁸. The second reason is for improving the cost estimates and thus the assessment of the investments attractiveness.²⁴⁹

²⁴⁶ (Ministry of the environment, 2012)

²⁴⁷ (Paalatie, 2014)

²⁴⁸ (Ministry of Justice, 2006; Yli-Teevahainen, 2013)

²⁴⁹ (Work document, 2014)

5.2.2.3 Stakeholders

5.2.2.3.1 The public and surrounding citizens

As written in section 5.1.4.1.2 the public opinion is in general pro wind power but people living close to wind parks can be disturbed by them due to visual, noise, or shade flashing effects. The national anti-wind organisation as well as local organisations with the same purpose often mention these disturbances when arguing against wind power. These organisations try to change the public opinion into a negative mind-set towards wind power causing a slowdown of the process as more citizens send in their objections during the EIA process and are more likely to appeal the construction permit.

5.2.2.3.2 The ELYs and municipalities

According to Esa Koskenniemi at the ELY in Vaasa, the ELYs treat the citizens and developers which they are in contact with as customers and work hard to deliver their part of the EIA in a professional and timely manner.

Among the municipalities there are variations. Some, like the municipality of Närpes, are pro wind power and have thus been proactive and planned large areas for wind developments²⁵⁰. The main reason for their positive attitude towards wind power is that it brings work and tax incomes through the property tax on wind power which is paid to the municipalities²⁵¹.

5.2.2.3.3 Other authorities

In addition to the ELY's and municipalities developers need to contact other authorities to obtain the required permits. Some permits such as the aviation interference given by the traffic safety authority is always needed, while others can be needed depending on the area.

5.2.2.3.4 Consultants

During this phase several types of consultants can be used. Especially in the EIA process many developers use consultants for writing the assessment program and the impact description.²⁵²

5.2.2.3.5 The grid owner

The grid owner is involved in planning all the possible grid connection for the EIA together with the developer and potential consultants.

²⁵⁰ (FCG Design och planering Ab, 2013)

²⁵¹ (Svenska Yle, 2014)

²⁵² (Yli-Teevahainen, 2013)

5.2.2.4 Financial

No incomes are generated during this phase. Costs always occurring are those for the EIA process paid to the ELY, fees for other permits, cost for environmental studies and fees and the rental cost for the wind measurement equipment. The rental fee for a wind mast ranges from 0.18 - 0.27 MEUR and the cost environmental studies 0.9 MEUR. As in the previous phase labour costs also arise. Fees occurring sometimes are: consultancy fees and the fee for development of a detail plan, the developer can be required to pay the total or a portion of that fee.

5.2.2.5 Future

Improvement potential in this phase is closely related to the processes and time frame for the involved authorities and agencies. In 2012 Minister Lauri Tarasti presented a report on needed improvements to speed up the planning and permit process of wind power. Some of his suggestions for example that of a compensation area for wind power in the bay of Bothnia have already come into effect. Other suggestions such as transferring the aviation interference permit process to the ministry of communication and to give operation permits to wind energy producers with limitation on operation during the holiday season from Midsummer Eve to August 10th, have still not come into effect. The reason is to reduce the noise levels during the holiday season when the cottages are full of people. Other times during the year the noise level in these areas is not as big of a problem.²⁵³.

One of Tarasti's suggestions was that the tax revenues that the municipalities receive from wind power should increase²⁵⁴. According to recent statements from the federal government they want to do the opposite and take half of the property tax which would decrease the monetary incentive for municipalities. The money will be used for tax equalization between municipalities²⁵⁵. Some claim that a decrease will increase the opposition of wind power since it becomes less lucrative^{256, 257}

The Ministry of the Environment has published three guidelines concerning modelling of wind power noise emissions, a new decree with the allowed

²⁵³ (Ministry of employment and the economy, 2012)

²⁵⁴ IBID

²⁵⁵ (Svenska Yle, 2014)

²⁵⁶ (Helsinki Times, 2014)

²⁵⁷ (Paalatie, 2014)

levels is believed to be presented in January of 2015²⁵⁸. The chairman of the Finnish wind power organisation Jari Suominen said in a presentation at the Vaasa Wind Exchange in March 2014 that he is very worried about the probable new noise levels. If they become 35 dB for both day time and night time in recreational areas he believes that they will kill 1/3 of all current wind projects in the pipeline, 1/3 might survive and only the last 1/3 will survive²⁵⁹. On the other hand the Minister of the Environment Ville Niinistö said in his speech at the same conference that he is positive about what the new noise level regulations may be²⁶⁰.

The Finnish government has suggested changes in the Land Use and Building Act to simplify the planning of wind power in industrial area and harbours. The reasoning is that in such areas already containing tall buildings a wind turbine will have a smaller effect on the surrounding environment. The change would be for a solitary wind turbine.²⁶¹

5.2.2.6 Risks

For an area to be available for wind development it needs to be planned for that purpose in one of the area plans as written in section 5.2.2.1 thus the first large risk in this phase is that wind development for some reason is not allowed in such a plan. Further on in the process the risk of not being granted any of all the needed permits is a major one. The final major risk is to be denied the construction permit.

5.2.3 Execution – Establishment

The purpose of this phase is to conduct a tendering process for the purchase of WTGs and the big construction works i.e. civil and electrical works. By the use of a tendering process the wind developer can compare manufactures and contractors on price and other factors and thus find the most feasible one. First an overall tendering process will be described and later the specific tenders for the purchase of the products and services listed above will be examined.

²⁵⁸ (Liukko, 2014b)

²⁵⁹ (Suominen, 2014)

²⁶⁰ (Niinistö, 2014)

²⁶¹ (Ministry of the environment, 2013c)

5.2.3.1 Activities

5.2.3.1.1 The onshore wind power tendering process²⁶²

To increase competition among suppliers several industries use a tendering process for procurement, wind developers are one of them. For wind power, tenders are used for the procurements of wind turbines, the civil works and electrical works. These tendering processes are similar in structure but vary in time required. The process is started with the development of a procurement strategy specifying the time frame and assessing the markets for the products and service to be procured. The next step is to develop a technical specification document including all the technical specifications from the permit, onsite limitations due to topography and other specifications needed. Simultaneously with the technical specification a prequalification of suppliers is ongoing. The suppliers are qualified on e.g. their overall financial situation and their experience in the field. During the prequalification the developer also clearly states on what grounds the suppliers and their tenders will be evaluated.

The technical specification is sent together with a non-disclosure agreement (NDA) and a contract proposal to the prequalified suppliers through a process called invitation to tender (ITT). Based on the information in the ITT the suppliers develop tenders which they return to developer.

The developer evaluates the suppliers' tenders and hold clarification meetings to ensure that the parties fully understand each other. When the evaluation is finished the developer has shortlisted the suppliers with whom they will continue negotiations. Suppliers who are not shortlisted will receive an explanation with the reasons why. The evaluation and negotiations can be an iterative process in which some suppliers withdraw or are excluded and others continue. The process is finished when a contract is signed.

²⁶² (Ståhlberg, 2014)

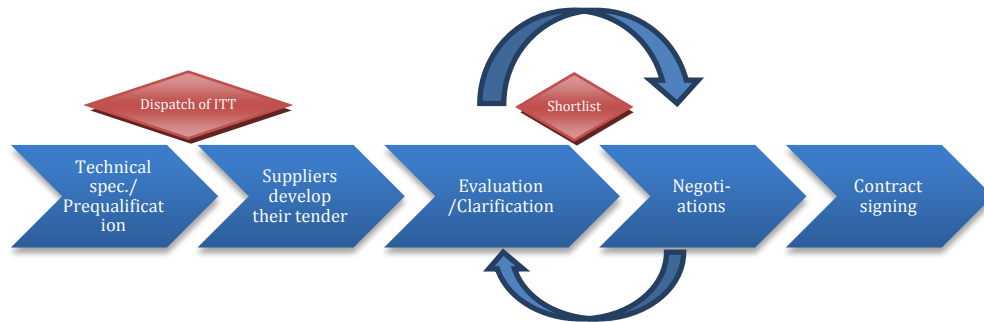


Figure 25: Onshore wind power tendering process²⁶³

5.2.3.1.2 WTG tendering²⁶⁴

The WTG tendering is always the first one since the choice of turbine sets the requirements for: the roads (causing limitations on the curving and the weight requirements), the hardstands (as larger turbines require larger cranes and thus larger hardstands (crane areas)) and the grid connection (which is affected by the wind parks total effect). The technical specification for the WTG tendering includes warranties and service and maintenance for 2-5 years. The shorter time is used when procuring turbines with well-established technology and the longer time for newer turbine technology. The technical specification also includes transportation and erection of the turbine. The WTG tendering in general requires approximately 12 months.

5.2.3.1.3 Civil and electrical works tendering²⁶⁵

The civil and electrical works tendering process is not as technical advanced as that of the WTGs and national industry standards exists for the construction of roads and casting as well as for electrical wiring and switchgears. Usually one supplier is awarded the contract for all of the civil works. The processes in general require approximately 6 months and can be

²⁶³ (Ståhlberg, 2014)

²⁶⁴ IBID

²⁶⁵ IBID

started simultaneously with the WTG tendering. The order of the civil works and electrical work tendering varies.

5.2.3.1.4 Submission of advanced notification

A developer needs to submit an advanced notification to the EA at least one month after the decision to start construction, in accordance with section 5.1.4.1.4.2.1.

5.2.3.2 Stakeholders

5.2.3.2.1 WTG manufactures

The market for WTGs is a global market with producers from many countries and several continents. As written in 5.1.4.1.8 icing is a problem occurring with various severity throughout Finland. For wind developers there are two ways to cope with icing: one is to budget for a production loss during the time the turbines need to be stopped due to icing, the other is to buy a WTG with the novel de-icing or anti-icing technologies, currently several suppliers offer such.^{266,267}

Of the installed Finnish capacity in 2012, Vestas, WinWinD and Siemens had roughly 25 % each and Enercon was the fourth largest with 11 %. Other suppliers with installed turbines were Harakosan, Nordex, Mervento and Hyundai. These numbers show that market is global and that wind developers have many suppliers to choose from. The two manufacturers WinWinD and Mervento are Finnish companies²⁶⁸. Due to unfavourable market conditions WinWinD filed for bankruptcy in late 2013²⁶⁹.

The price of wind turbines has been volatile during the last decade, first there was a shortage of supply but as existing manufactures added more capacity and new came into the market, the financial crises hit and the demand fell²⁷⁰. The long term trend is towards lower prices due to technical development enabling larger turbines²⁷¹. Currently turbine manufactures have excessive production capacity driving prices down²⁷².

²⁶⁶ (Wind Power Monthly, 2013)

²⁶⁷ (Wind Power Monthly, 2014)

²⁶⁸ (IEA, 2013)

²⁶⁹ (WinWinD, 2013)

²⁷⁰ (Financial Times, 2012; Bloomberg , 2012)

²⁷¹ (EWEA, 2009)

²⁷² (Bloomberg Businessweek, 2014)

5.2.3.2.2 The energy authority

Receive and file the advanced notification for acceptance in the subsidy system.

5.2.3.3 Financial

No incomes are generated during this phase. The cost occurring during this phase is labour cost and consultancy fees if such are used. Since the phase consumes quite a lot of time and work the cost can be 0.45MEUR. Usually a down-payment of 10 % is made as the turbines are ordered.²⁷³

5.2.3.4 Future

The advanced notification as explained in section 5.1.4.1.4.2.1 is to be replaced by a “quota decision” which will decrease the uncertainty of inclusion in the subsidy system. With the *quota decision* a decision on inclusion in the subsidy system will be given to owners of a wind park with a building permit and a grid connection.

5.2.3.5 Risks

In the negotiations during the tendering processes risk that might arise in the coming phase are attended and the final contracts includes clauses on responsibilities of risks for the parties.

5.2.4 Execution – Realisation

In this phase the contracts signed during the tendering are realised. Wind developer usually act as project leaders while contractors are responsible for construction and the wind turbine manufacturer for the delivery and erection of the turbine²⁷⁴. A common practice is that construction contractors use subcontractors for some of the tasks. During the realisation phase the largest proportion of the total cost of wind power development occur. The biggest risks are delays in either construction or turbine delivery.

5.2.4.1 Activities

The common practice is to perform the activities in the order described below. For the first three activities another order can vary but all of them need to be finished before the erection of the turbine can be started.²⁷⁵

The best season for all of the following activities in the Nordic and Finland is the summer, due to warmer and less windy conditions. The casting can be

²⁷³ (Work document, 2014; Lundberg, 2014)

²⁷⁴ (Ståhlberg, 2014)

²⁷⁵ (Lundberg, 2011)

started when the ground frost has vanished. The erection of turbine is easier in the summer due to lower wind speeds. In the summer the road availability is also better since there is no snow and the roads are not slippery.²⁷⁶

5.2.4.1.1 Electrical wiring

The electrical wires are dug into the ground or put into cable ditches²⁷⁷ in accordance with regulations of the regional grid company. The turbines need a transformer station that is put in the tower or separately in a small house. Parks may need a separate transformation station and aerial line wiring to the connection point of the grid²⁷⁸. As written in section 5.2.2.2.3.6 the size of the park determines if is connected to the lower voltage distribution grid or the higher voltage regional grid.

5.2.4.1.2 Roads

The roads are either constructed simultaneously with or after the electrical wiring. A typical road has a coating of 20-40 cm of gravel and is 5-6 meters wide.²⁷⁹

5.2.4.1.3 Foundation and hardstand

A typical foundation for one turbine is about 225 m² with a depth of 1.5 meters in the centre; it's made of reinforced concrete. As many as 90 trucks of concrete can be needed and the casting is done in one day. The concrete needs to harden for 2-3 months, but the process can be sped up by additives. When there is solid rock close to the surface the foundation can be anchored in this instead.²⁸⁰

The hardstand is a flat gravelled area of approximately 25×40 meters where the crane can be rigged and the turbine parts unloaded²⁸¹. Larger turbines require larger cranes and thus larger hardstands²⁸².

Local contractors can be used but they need to follow the instructions given by the turbine supplier. Therefore it is necessary to have a good controller giving the contractors specific tasks and controlling their work.²⁸³

²⁷⁶ (Ståhlberg, 2014)

²⁷⁷ (Lundberg, 2011)

²⁷⁸ (O2, 2013b)

²⁷⁹ IBID

²⁸⁰ IBID

²⁸¹ IBID

²⁸² (Ståhlberg, 2014)

5.2.4.1.4 Erection of turbine

The turbine manufactures are usually responsible for transportation of the turbine to the wind park as well as for the erection at the site. The manufactures hire contractors to perform those tasks²⁸⁴. A turbine can be erected in one day²⁸⁵.

As written in 5.2.4.1 the summer is the best season for all of the activities above. The further north one goes the shorter is the summer season is. Due to short season and the hardening time of the casting, for some projects in the north it can be necessary to cast the foundations during one summer and erect the turbines the following summer.²⁸⁶

5.2.4.2 Stakeholders

5.2.4.2.1 WTG manufacturer

As written above the WTG manufacturer is responsible for the delivery and erection of the turbine.

5.2.4.2.2 Civil work contractors

The civil work contractors are responsible for the roads, foundation and hardstand. Usually the same contractor is used for all three.²⁸⁷

5.2.4.2.3 Electrical work contractors

The civil works contractors are responsible for the internal electrical grid and the connection to the external grid.

5.2.4.2.4 Subcontractors

All of the actors above often use subcontractors for some of the tasks. Even though the wind developer meets them at the site and might have contact with them, the main communication is through the contractors.

5.2.4.3 Financial

No incomes are generated during this phase. The largest proportion of the costs occurs during this phase. As shown in the turbine is the absolute most expensive part of a wind project. It accounts for between 75-80 % of the total investment cost of the project. Numbers from Finland in 2012 estimates the

²⁸³ (Lundberg, 2011)

²⁸⁴ (Ståhlberg, 2014)

²⁸⁵ (Lundberg, 2011)

²⁸⁶ (Ståhlberg, 2014)

²⁸⁷ IBID

cost of turbines and installation to be 1.3 - 1.4MEUR/MW²⁸⁸ and interviews in this study 1.17 - 1.5 MEUR/MW²⁸⁹.

Activity/ product	Share of total cost [%]
Turbine (inc. work)	75 - 80
Civil works	11 - 18
External grid	4 - 7
Internal grid	2 - 6

Table 7: Cost structure of a typical 3 MW wind turbine²⁹⁰

The first 10 % of the turbine is often paid on the order date, as the turbines then are delivered approximately another 70 % is paid, the next 10 % is paid when they are operational and the last 10 % after all checks and test are done. The civil works and electrical works are usually paid gradually after predetermined milestones are finished.²⁹¹

5.2.4.3.1 Connecting to the grid

The developer carries all costs of the connection to the grid, including costs for a new substation if needed. It is difficult to appraise the cost of a new substation or even transformer station as there are many factors affecting the price. It is however a substantial sum thus the developers strives to connect the farm to a suitable grid. Most grid owners also administer a one-time connection fee when connecting, i.e. Fingrid charge the following fees.

Grid connection solution	Fee [MEUR]
Connecting to an existing 400 kV substation	2.0
Connecting to an existing 220 kV substation	1.2
Connecting to an existing 110 kV substation - The connector bears the full cost if a new substation needs to be built for the connection to the transmission grid.	0.6
Connecting to a 110 kV power transmission line - If additional transformer of a maximum of 25 MVA is added to the same power line connection, the customer pays a connection fee of 0.5 M€ for it. In case, the electricity transmission in the main grid caused by the substation does not exceed 25 MVA, a connection fee is not charged from the customer.	0.5

Table 8: Fingrid's Grid connection solutions and fees 2014²⁹²

²⁸⁸ (IEA, 2013)

²⁸⁹ (Work document, 2014; Stormoen, 2014)

²⁹⁰ (Work document, 2014)

²⁹¹ IBID

²⁹² (Fingrid, 2014e)

5.2.4.4 Future

As wind developer become more experienced they learn from their experience and can improve their internal processes and project management. One way for the wind developers to cut the cost of the turbine is to integrate forward and take responsibility for the transportation and erection. Such an action would increase the risks that the developer bears. As is today the turbine manufactures bear the risk of the transportation and erection of the turbines. If a developer would contract a company for the transportation and erection they would have to bear the risk as well. If several contractors are involved the risk of them blaming each other for delays or other problems increase.²⁹³

5.2.4.5 Risks

The major risks of this phase are delays and faulty construction. Delays can occur due to several reasons e.g.: severe weather or accidents causing transportation delays, delays in the production of the turbine or construction of the civil and electrical work for many different reasons. If the quality of e.g. the electrical work is poor this can cause future production loss which is very costly. The responsibility for these risks as well as fines for delays is contracted in the tendering process.²⁹⁴

5.2.5 Execution – Handover

This phase varies with the agenda of the actor building the wind park. For developers not aiming to run the park themselves this is the phase during which the park is handed over to their external investor. If the park is built by a utility or a developer with the purpose of keeping the park for electricity generation this is an internal phase during which the park is handed over to the team responsible for operations.

5.2.5.1 Activities

5.2.5.1.1 Verification of turbine, electrical and civil works

Checklists are a part of the contracts with suppliers, in this phase they are used to verify the delivery and installations. The turbines and electrical works are also checked by conducting 120 h and 240 h operational tests. If faults or incorrect installations are discovered a third party consultant can be used to decide who is responsible.²⁹⁵

²⁹³ (Ståhlberg, 2014)

²⁹⁴ IBID

²⁹⁵ IBID

5.2.5.1.2 Submission of application for the feed-in tariff system

As written in 5.1.4.1.4.2.2 the owner of a wind park needs to submit an application for inclusion in the feed-in tariff system before the park is in commercial operation. The application should include verification from a third party controller on several factors listed in the section written above for example: that the wind turbines and grid connection is situated on Finnish territory and an estimate of the annual electricity production. As described in 5.1.4.1.4.2.3.2 when the application is approved the owner of the production facility will receive a final decision on inclusion. The right to receive the subsidy comes into effect the price period after the inclusion is approved.

5.2.5.2 Stakeholders

5.2.5.2.1 Financial investors

Several financial investors are active on the Finnish wind power market with the purpose of owning wind parks. Their reason for investing can be that the market is undervalued and the long-term and stable returns created by the feed-in tariff system.²⁹⁶ The investments can be through funds with a renewable energy focus.²⁹⁷

5.2.5.2.2 The Energy authority

The Energy authority handles the approval decision process and submits the final decision to the owner of the wind park.

5.2.5.2.3 Third part controllers

Two types of third party controllers exist. The first type is hired by wind developers to check who is responsible for incorrect installations. The second type needs to be approved by the Energy authority and verify the requirements in the application for the subsidy system.²⁹⁸

5.2.5.3 Financial

No incomes are generated during this phase. Labour costs and consultancy fees to the third party controllers are the main costs of this phase.

5.2.5.4 Future

As the Finnish wind market becomes more mature industry standards for construction and installations will be further developed making the

²⁹⁶ (Impax asset management, 2014)

²⁹⁷ (Taaleritehdas, 2014)

²⁹⁸ (The Energy Authority, 2014f)

inspections smoother and decreasing the risk for incorrect installations and construction.

5.2.5.5 Risks

The main risk during this phase is discovery of faulty construction in need of replacement or rework and thus causing delays.

5.2.6 Generation

Naturally this is the longest phase in the life cycle of a wind park as the lifetime of a wind turbine is between 20-30 years. The phase consists of some one-time activities and some reappearing. As the turbines grow older the need for and cost of service and maintenance increase.

5.2.6.1 Activities

5.2.6.1.1 Submission of production report

As written in 5.1.4.1.4 to receive the subsidy a production report verified by a third party controller needs to be submitted at the latest two months after the end of the price period.

5.2.6.1.2 Operation and maintenance

Operation and maintenance of the park is performed by the wind turbine manufacturers during the warranty period. By the end of that period there are many options for the continuance of that service. Some bigger owners such as utilities chose to perform the service internally, the turbine manufacturers offer longer service deals up to 15-20 years and there are also third part market consisting of wind developers and consultancies.²⁹⁹

The parts to wear out the fastest are the moving parts and those exposed to weather thus the gearbox and the blades are the major components that wear out the fastest.³⁰⁰

When analysing the failure rate, down time and replacement costs of the main critical components a gearbox failure has the biggest negative effect, it is followed by failure in the electrical systems such as switchgears, converters and generators.³⁰¹ For the gearbox and other moving parts regularly oil change is necessary.

²⁹⁹ (Ståhlberg, 2014)

³⁰⁰ (Wind measurement international, 2014)

³⁰¹ (Bertling Tjernberg & Wennerhag, 2012)

5.2.6.1.3 Optimisation

To run the operations as smooth as possible it is important to optimise the maintenance with aspect to safety of the workers as well as minimal production loss. Having sufficient wind and weather data can contribute to this. The data also gives the possibility to check if the turbine is performing as it should at different wind speeds and to ensure that the turbines are turned off when required at high wind speeds to decrease the wearing on components.³⁰²

5.2.6.1.4 End of warranty handover

By the end of the warranty (EOW) period a handover of the operations and maintenance responsibility is conducted. Before the new actor takes over this responsibility it is important to make a thorough EOW inspection of the turbines to find all the faults or worn out and nearly worn out components that can be replaced under warranty. Many wind park owners' experience a tapering in the operating profit after the warranty is ended due to increase maintenance costs, showing the importance of the EOW inspection.³⁰³

5.2.6.2 Stakeholders

5.2.6.2.1 The Energy Authority

Receives and handles the production report and pay out the subsidy.

5.2.6.2.2 WTG manufactures

The WTG manufactures are responsible for operation and maintenance during the warranty period. By the end of that period they compete with consultancies and the internal services of larger wind park owners on the proceeding operation and maintenance contracts.

5.2.6.2.3 Consultants

Consultants offer various services such as operations and maintenance and optimisation.

5.2.6.2.4 Third part controllers

The third part controllers verify the production reports. They need to be approved by the Energy Authority

³⁰² (Vaisala, 2014)

³⁰³ (Gupta, 2014)

5.2.6.3 Financial

During this phase the incomes of the project are generated through the sales of electricity and for 12 years by the FIT - subsidy.

The operation and maintenance (O&M) costs of a wind turbine in general accounts for as much as 20-25% of the levelized cost of energy over the turbines lifetime. They are lower when the turbine is new 10-15% and by the end of its life they increase to 25-35%. The O&M can be broken down into³⁰⁴:

- Insurance.
- Scheduled maintenance.
- Unscheduled maintenance.
- Spare parts.
- Administration.

Insurance, scheduled maintenance and administration are easy to estimate while unscheduled and spare parts are more volatile and harder to estimate. Scheduled maintenance ranges from €36-45k/turbine/year and unscheduled € 1.8-2.25/MWh. Most of the costs tend to increase but the repairs and spare parts are especially influenced by the age of the turbine.³⁰⁵

5.2.6.3.1 Other costs and taxes

The other costs are land lease described in 5.2.1.1.2, property tax, corporate tax, and grid tariffs. The starting taxation value for the property tax is the replacement cost which is 75 % of the construction costs of the tower and foundation³⁰⁶. The cost of a foundation is around 0.2 MEUR and the tower cost is approximately 28 % of the total turbine cost³⁰⁷. The annual deduction of the initial replacement cost is 2.5 %; the deductions are the same size per annum. The minimum taxable value is 40 % of the replacement cost (is reached in 24 years)³⁰⁸. In Finland the municipalities decide the level of property tax and collect it. The general property tax for 2014 is 0.6-1.36 % and is applicable for wind power plants with a maximum nominal effect of 10 MVA. Currently all installed wind turbines in Finland have a nominal effect below 10 MVA. For

³⁰⁴ (EWEA, 2002)

³⁰⁵ (Work document, 2014)

³⁰⁶ (Finland's Ministry of Employment and the Economy, 2013b)

³⁰⁷ (Ståhlberg, 2014)

³⁰⁸ (Finlex, 2005)

larger wind parks the maximum percentage is 2.85³⁰⁹. The corporate tax in Finland is 20 %.³¹⁰

The grid tariffs differ depending on the network owner, but are closely watched by the EA to be reasonable. Larger projects may even connect to Fingrid that charges the fees below:

Type of fees	Fee [€/MWh]
Consumption fee (1/1 - 31/3, 1/11-31/12)	4.22
Consumption fee (1/4-31/10)	2.11
Output from the main grid	0.95
Input into the main grid	0.85

Table 9: Grid service fees 2014 in Fingrid's transmission grid³¹¹

5.2.6.4 Future

As the turbine technology develops the need for service and maintenance might decrease. An example of that is a new direct drive design without a gearbox. Since the gearbox is an expensive part put to a lot of mechanical stress and with a big need for service and replacement, the new design reduces the need for service and replacement and thus the cost.³¹²

Condition monitoring systems (CMS) with several sensors on strategic positions in the turbine are designed to detect when something is about to go wrong before it actually does and thus reducing the down time. For example change in vibrations is a good indicator on that a machine part is about to wear out. Such systems will likely become more sophisticated in the future.³¹³

5.2.6.5 Risks

The main risk in this phase is break down of a critical component causing down time for the turbine and thus production loss. The other main risk in the generation phase is the spot price affecting the revenues. The FIT secure the attained price for 12 years, but after that the owner only attain the spot price. This issue is more thoroughly described in section 5.1.3.2.2.

³⁰⁹ (Vero, 2014a)

³¹⁰ (Vero, 2014b)

³¹¹ (Fingrid, 2014d)

³¹² (EWT, 2014)

³¹³ (Milborrow, 2010)

5.2.7 Summary of costs

The table below shows a summary of the cost in an onshore wind power project. Approximately 75 % of the costs occur during the realisation phase and the remaining 25 % during the generation phase.³¹⁴

Process	Costs
Analysis	< € 27 k / project
Planning	0.6 – 1.8 MEUR / project
Wind mast	0.18 – 0.27 MEUR / mast
Environmental studies	0.9 MEUR
Sodar	€ 5.2 k in rent or € 25 k / annum if owned
Execution establishment	0.45 MEUR / project
Execution realisation	1.1 – 1.5 MEUR / MW
Execution hand-over	
Generation	
Scheduled maintenance	€ 36 – 45 k / turbine / year
Unscheduled maintenance	€ 1.8 – 2.25 / MWh
Land lease	4 % of revenues
Property tax	Max 1.36 % of property value
Grid	€ 0.85 / MWh or € 15 k / month + € 0.5 / MWh ³¹⁵

Table 10: Summary of main costs during the project process

³¹⁴ (Work document, 2014)

³¹⁵ (Fortum, 2013)

6 Evaluation

This chapter evaluates the wind power market in Finland in two categories, a quantitative and a qualitative part. The quantitative analysis is based on capital budgeting and a "typical" Finnish reference project is evaluated. The qualitative part weights different key factors against each other to evaluate the business case.

6.1 Quantitative analysis

The evaluation model from section 4.3.2 is applicable onto a Finnish wind power project. Some changes were made to adapt the model onto the special conditions of the Finnish market with e.g. the FIT. The model is presented below and the cost and benefits are expressed in MEUR:

$$\begin{aligned}
 NPV = & - \sum_{n=1}^{t_1} \frac{CC_n * (1 + i_n)^n}{(1 + r)^n} \\
 & - \sum_{n=1+\sum_{m=1}^2 t_m}^{\sum_{m=1}^2 t_m} \frac{CC_n * (1 + i_n)^n}{(1 + r)^n} - \sum_{n=1+\sum_{m=1}^3 t_m}^{\sum_{m=1}^3 t_m} \frac{CC_n * (1 + i_n)^n}{(1 + r)^n} \\
 & - \sum_{n=1+\sum_{m=1}^4 t_m}^{\sum_{m=1}^4 t_m} \frac{CC_n * (1 + i_n)^n}{(1 + r)^n} - \sum_{n=1+\sum_{m=1}^5 t_m}^{\sum_{m=1}^5 t_m} \frac{CC_n * (1 + i_n)^n}{(1 + r)^n} \\
 & + \sum_{n=1+\sum_{m=1}^{\Sigma t_m + 12}}^{\Sigma t_m + 12} \frac{CB_n}{(1 + r)^n} \\
 & + \sum_{k=\sum T_m + 13}^{\Sigma T_m + N} \frac{CB_n}{(1 + r)^n} - \sum_{n=1+\sum t_m}^{\Sigma t_m + N} \frac{CC_n * (1 + i_n)^n}{(1 + r)^n} \\
 & - \sum_{n=1+\sum t_m}^{\Sigma t_m + N} \frac{CC_n}{(1 + r)^n} = 0
 \end{aligned}$$

Where,

- m = phase m in the project
- t_m = time of phase m in years; $t_m \in \mathbb{N}$
- N = lifespan of the investment
- i_n = the predicted inflation year n
 - i_n is assumed to be 1.4 % in 2014 and gradually increase to 1.9 % within five years and then stay at 1.9 %

Before describing each phase and its corresponding cash flow closer, three variables are defined:

- $x = \text{number of wind turbines in the project}$
- $y = \text{effect of each of turbines in MW}$
- $HR_m = \text{Project hit-rate in phase } m \text{ (probability of entering the next phase)}$

The values used are based on the described costs occurring in each phase from table 10

6.1.1 Analysis phase (m=1)

$$CC_n = \frac{0.03}{HR_1 * t_1} \quad \text{for } 1 \leq n \leq \sum_{m=1}^1 t_m$$

Where $HR_1=1/3$

6.1.2 Planning phase (m=2)

$$CC_n = \frac{\left(\frac{1.0}{t_2} + 0.2 * \frac{x}{10}\right)}{HR_2} \quad \text{for } 1 + \sum_{m=1}^1 t_m \leq n \leq \sum_{m=1}^2 t_m$$

Where the term $\left(\frac{x}{10}\right)$ is rounded off to the closest larger integer and only valid for $n = 1 + \sum_{m=1}^1 t_m$.

Also, $HR_2 = 0.5 + 0.1 * (n - \sum_{m=1}^1 t_m)$. It was assumed that the probability of taking a project past TG2 increases over time.

6.1.3 Establishment phase (m=3)

$$CC_n = \frac{0.5}{t_3} \quad \text{for } 1 + \sum_{m=1}^2 t_m \leq n \leq \sum_{m=1}^3 t_m$$

6.1.4 Realisation phase (m=4)

$$CC_n = \frac{1.1 * x * y + \text{civil works}}{t_4} \quad \text{for } 1 + \sum_{m=1}^3 t_m \leq n \leq \sum_{m=1}^4 t_m$$

Where civil works approximately are 19-25 % of the turbine cost.

6.1.5 Hand-over phase (m=5)

Describes the hand-over phase but was assumed not to affect the cash flow at all, thus $CC_n=0$ and $t_5=0$.

6.1.6 Generation phase (m=6)

$$\sum_{n=1+\sum t_m}^{\sum t_m+12} \frac{CB_n}{(1+r)^n} + \sum_{n=\sum t_m+13}^{\sum t_m+N} \frac{CB_n}{(1+r)^n} - \sum_{n=1+\sum t_m}^{\sum t_m+N} \frac{CC_n * (1+i_n)^n}{(1+r)^n} - \sum_{n=1+\sum t_m}^{\sum t_m+N} \frac{CC_n}{(1+r)^n}$$

$CB_n = \text{selling price} \times \text{yearly production}$

$\text{Yearly production} = \text{average energy output} \times \text{hours in a year} \times \text{estimated operational availability} / 10^6$

$$\text{Average power output (APO)} = P_{kin} = \frac{1}{2} \rho A v^3 C_p$$

where,

- $C_p = 0.25 - 0.4$ depending on the turbine
- $v =$ the annual mean wind speed
- $A =$ the area of the rotor
- $\rho =$ density of air

Thus,

$$CB_n = FIT * \frac{1}{2} * \rho * A * v^3 * C_p * \frac{8760}{10^6} * EOA * x \quad \text{for } \sum T_m \leq n \leq \sum T_m + 12$$

and

$$CB_n = \overline{SPOT PRICE} * \frac{1}{2} * \rho * A * v^3 * C_p * \frac{8760}{10^6} * EOA * x \quad \text{for } \sum T_m + 13 \leq n \leq \sum T_m + N$$

The positive cash flow during the first 12 years of operation was not affected by inflation due to the construction of the FIT. The predicted spot price was adjusted with the inflation.

The negative cash flow CC_n during the generation is described below and was divided into two categories depending on whether the cost follows the inflation or not.

6.1.6.1 Costs affected by inflation

Scheduled O&M: $40 \times x$

Unscheduled O&M: $2 \times x \times y$

Grid tariff: $\text{Annual output} \times 0.85 = [\text{assumed connection to Fingrid. Could also be a fixed monthly charge and a lower tariff per MWh}]$

Balance power: $\text{Annual output} \times 2 [\text{assumed value}]$

6.1.6.2 Costs unaffected by inflation

Land lease: $CB_n \times 4 \%$

Property tax: 1.36% \times replacement cost of tower and foundation

Replacement cost year $k = c_r \times 75 \%$ $\times (1 - (k-1) \times 2.5 \%)$

Taxable realisation cost $= c_r = \frac{2}{9} + 28 \%$ $\times \sum_{n=1+\sum_{m=1}^3 t_m}^{\sum_{m=1}^4 t_m} \frac{CC_n \times (1+i_n)^n}{(1+r)^n}$

Thus, property tax:

1.3% $\times c_r \times 75 \%$ $\times (1 - (n - (1 + \sum t_m)) \times 2.5 \%)$ for $n \leq 23 + \sum t_m$

6.1.6.3 Other factors affecting the NPV and IRR

Corporate tax: 20%

Depreciation: Digressive depreciation by 25% of replacement value

6.1.7 Reference project

The financial model presented above was applied to a fictional reference project with an average effect and wind speed of wind power projects in the project pipeline in Finland. To illustrate the difference of when, and how, to start a project two alternatives were evaluated:

Assumption for p1:

- Greenfield, the project was started from scratch in 2014 and generation started in 2020 (end by 2039).
- $t_1=1, t_2=3, t_3=1, t_4=1, t_5=0, t_6=N=20$.

Assumption for p2:

- Brownfield, started in phase 4, thus generation started in 2015 (end by 2034).
- Permit premium 3.6MEUR and added to investment in 2014.
- $t_4=1, t_5=0, t_6=N=20$.

All other variables were the same for both starting years, given a 2014 price level:

- $x = 12$ wind turbines.
- $y = 3$ MW turbine.
- $WACC = 8 \%$.

For m=4:

- Civil works = 5MEUR = 13 % of WTG cost.
- External grid connection = 2.5MEUR = 6 % of WTG cost.
- Internal grid connection = 1.0MEUR = 2.5 % of WTG cost.

For m=6

- $\rho_{air} = 1.25 \text{ kg/m}^3$.
- $A = \pi * r^2 = [3 \text{ MW turbine, assumed rotor radius 60 meter}] = \pi * 60^2 = 11304 \text{ m}^2$.
- $v = 7 \text{ m/s}$ = [average mean wind speed at 120 m in Finland]
- $C_p = 0.4$.
- Operational availability = 95 %.

The inflation rate was assumed 1.4 % in 2014, slowly increasing to 1.9 % in 2019 and then kept steady at 1.9 % onwards according to ECB's inflation rate target. The spot-price was predicted through a linear extrapolation of Markedskraft's prognosis presented in figure 17. The graph is shown in figure 26 below together with the linear equation used to predict the spot-price.

Spot price prognosis in price area Finland

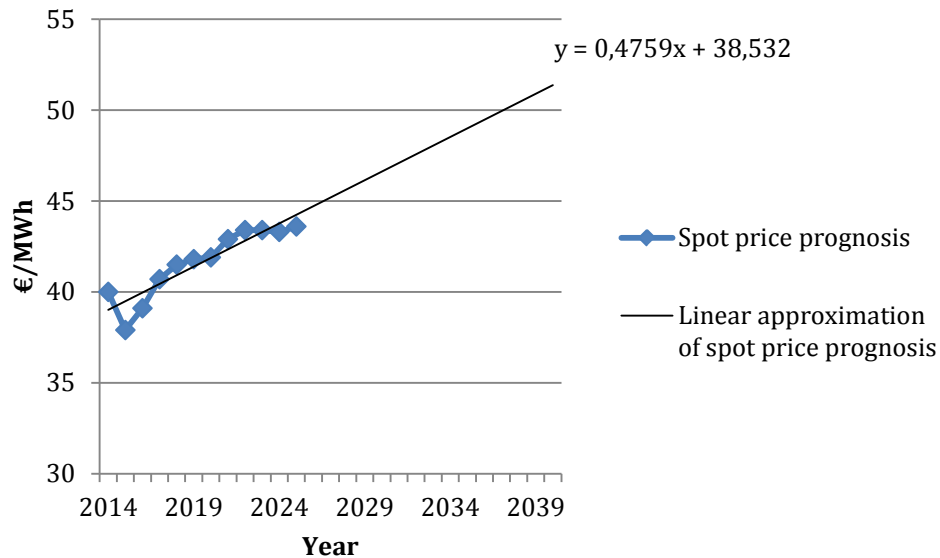


Figure 26: Spot price prognosis in price area Finland

The calculations were made in Microsoft Excel and the worksheet is found in Appendix 3: Excerpts from financial evaluation. The main results were:

Key factors	Project, generation 2020	Project, generation 2015
NPV [MEUR]	- 5.3	- 2.5
IRR [%]	5.6 %	7.1 %
LCOE [€/MWh]	75	63
CAPEX [MEUR/MW]	1.44	1.49

Table 11: Comparison of the same project started at different times

Given the 8 % WACC the reference project did not satisfy the criteria for investment, since the IRR is lower than the WACC meaning that a company with a cost of capital of 8 % would get a return less than that and thus be losing money. There is however a significant difference between the starting years. The first, describes a project that a developer started from scratch in 2014 and was assumed to be included in the FIT scheme. The second describes the same project but for which the construction would have been started in 2014. The added cost of 3.6MEUR is to cover the costs over the first three phases and could also describe a developer acquiring the project with permits, paying €100k/MW.

The evaluation reference indicated that a faster market entry gave a higher IRR. This particular project showed a higher IRR for “fast entry” and for a maximum permit purchasing cost of €250k/MW. The large difference in IRR is correlated with the inflation slowly digesting the tariff of €83.5/MWh over 12 years.

6.1.7.1 Validation³¹⁶

As for any wind project assumptions was needed to be made thus making validation harder. The calculations were validated by comparison with the following data from a real wind project from the working document:

At 7 m/s, a 3 MW turbine from *company X* has an annual output of 8550 MWh (after standardised losses and availability). The project’s annual output is then 103 GWh. The turbine price is 1.15 MEUR/MWh.

When inserted into the worksheet for generation in 2015 and all other assumptions stayed the same, the following values were given:

NPV = -1.6MEUR, IRR = 7.5 %, LEC = €66.2/MWh, CAPEX = 1.53MEUR/MW

The NPV and IRR were almost the same even with a more general approach to estimate the annual output, given the data from the turbine.

Every project has however unique specifications. The winds in Finland are lower than in the other Nordic countries, which are countered by the tariff. Also, projects with higher towers and larger turbines will increase the production. The reference project at 7 m/s, 120 m, 3 MW show indications that a project with IRR > 8 % need an average wind speed slightly higher than 7 m/s, or a turbine larger than 3 MW to extract more energy from the wind.

6.2 Qualitative analysis

The quantitative analysis was based on assumption but resulted in an absolute number, while the qualitative analysis showed more layers of interpretation but still indicated that Finland is profitable if the current conflict of interest concerning the FIT is resolved and the tariff is left untouched as Finns stand by their word.

6.2.1 Global

The recent conflict in Ukraine has raised issues of Europe’s dependency on Russian natural gas. So far, focus seems to have been more on discussing the

³¹⁶ (Work document, 2014)

issue and the geopolitical weapon Russia has against the west, rather than how to solve the dependency. The EU's recent economic sanctions against Russia are likely to hit the economy of many nations with close ties to Russia; Finland included. Even though Finland now has a low net import of electricity from Russia, basically all fossil fuels are imported and due to its geographical location Russia is a logical trade partner accounting for 8.5 % of the Finnish exports. If the Ukrainian crisis worsen more sanctions are likely to come, which will decelerate the Russian economy further and most likely hurt the Finnish exports and economy.

The Crimea conflict has led to postponement of the new energy 2030 targets that the EC presented in early 2014. According to Finnish stakeholders this poses a threat as the government will not engage in any discussions about future subsidy schemes until it is official what targets will need to be met. Also, the new bill concerning the state aid guidelines could possibly affect the current subsidy schemes in Europe.

The uncertainties in the political situation today pose a threat towards the commercial viability of wind power. RES need state subsidies, but politicians tend not to want to take decisions without absolute targets to meet. It is also problematic that the EU with differentiated countries and cultures try to institute collective binding targets that some countries are more likely to meet than others.

The real game changer is the result of the Åland-verdict by the European Court of Justice which is supposed to be decided within the foreseeable future. If the court rules in favour of Åland, it basically means that all national subsidy schemes are illegal. For Finland it would mean that a developer in for example Estonia could be included in the FIT system, paid for by Finnish taxpayers. This uncertainty would affect investments in renewable energy sources all over Europe, not just in Finland.

6.2.2 Finland

6.2.2.1 Politics

The political situation in Finland is problematic. The current coalition government is spread out over a wide spectrum of ideologies. This summer the government is also to change both prime minister and the minister of finance, less than a year ahead of the next election. The less favourable economic times in Finland does not increase the trust in the government when

they are to cut welfare spending. Meanwhile the nationalistic party FP is harvesting success and increases in popularity. The outcome of the 2015 election seems very unclear but could turn out to affect the wind power industry significantly.

Despite the claim that Finns are true to their word an apparent risk exists concerning the future of energy subsidies. Finland is one of few countries in the world investing in new nuclear power, and the pipeline of three new reactors covers approximately three times the current import of electricity and most likely the future increase in electricity consumption. As many wind developers are international companies, there is a possibility that the public will start to question the current tariff system since it is the taxpayers who cover the tariff and the profits are transferred to the respectively home country of the owners.

The economic and political problems are not as grave as it was in Spain when the government pulled back the subsidies. A more populist government that believe in nuclear power could however try to decrease the tariff and transfer the detached funds towards welfare spending. The projects in the system are not likely to be affected, but projects under development could be affected if such change was to happen.

So far, only 375 MW wind power is included in the FIT-system and thus the cost for the system is less than 1/5 of what it will be when the system is full with 2500 MW. As the system grow so will the cost and in these times of federal budget deficits the growing costs might increase the political pressure to decrease the tariff. Most likely such a change will not affect wind power already included in the system but instead wind power to be installed.

There are also political decisions to be made concerning what will happen after the current subsidy scheme is filled up. There is a target of 9 TWh for 2025 and the developers are expecting a new subsidy system, but the current politicians are unwilling to investigate the matter further. The government are even postponing discussions about it until after the 2015 election. What seems to be clear is however that if a new system is introduced, it will not be as beneficial as the current one. Reasons for this include current and most likely upcoming EU legislation, but could also be somewhat populist due to the previously mentioned reasons of transferring funds between the developers and the low income population.

6.2.2.2 *The anti-wind movement*

As previously written, both national and regional anti-wind movements are present in Finland. Some claim that they are loud and that the resistance has increased recently but developers with operations in both Sweden and Finland claim that the movement is as big in both countries and manageable. The developers present in both countries have the possibility to compare markets and are therefore considered to have a better understanding of the situation. It seems reasonable that the resistance might increase as people become more aware of the negative effects when more turbines are erected. On the other hand, it might also have the opposite effect as people realise that the negative effects were less than they thought and that some positive effects were discovered as well. Regional or local anti-organisations exist in some areas usually to stop a certain project. It is hard to tell if they are growing in number or not but a developer needs to carefully investigate the local resistance before moving into an area. If the federal government moves forward with its plans to take half of the proceedings from the property tax the local incentive will decrease and the local opposition might therefore increase.

6.2.3 Energy

Finland's clear strategy to become electricity independent by nuclear and wind expansion is much more clear than that of many other countries in the EU. By the time Olkiluoto 3 finally begins commercial operation Finland should be close to self-sufficient given that the wind power expansion has proceeded as predicted. The problems building Olkiluoto 3 have however led to delays of the next reactor, just like the changes in ownership of Hanhikivi 1 have. These delays make it difficult to predict what the future of the Finnish energy and electricity market will look like.

As written above Olkiluoto 3 and the added to be installed wind capacity of roughly 6 TWh will make up for the current net imports. If Olkiluoto 4 and Hanhikivi 1 would be built and become operational Finland would have an added electricity production capacity estimated to 23 TWh. Added to the electricity consumption in 2012 of approximately 85 TWh that would give a surplus of 27 %. If all the Finnish electricity production stayed at the same level as today that would most likely decrease the Finnish electricity prices, but since the electricity market is dynamic and highly integrated with other nations an outcome might be that Finland will export its surplus to its neighbours. Also, from 2027 and onward the current installed Finnish nuclear

power is estimated to start shutting down. As this happens the possible surplus will decrease quite rapidly.

The construction of Olkiluoto 3 has become much more expensive than the budget. As the new larger wind turbines are developed the cost of wind power slowly decreases. The energy market is highly politicised and there are large pro-groups for both wind and nuclear with calculations showing that their type of energy production is the cheapest. With money and propaganda each group can change the public opinion in favour of their beliefs, making it hard to predict further nuclear or wind power expansion.

The increased integration of the European grids and electricity markets are likely to affect Finland in some sense but the development of increased cross-border transmission capacity with neighbouring countries should affect more. The grid connection to Sweden with large hydro capacity guarantees clean electricity to Finland and as bottlenecks are phased out the spot price in Finland should approach the prices in Sweden and Norway. Figure 17 which show the spot price and flows at a point of time in March serves as a good indication of when the import is at max capacity. Despite the import, the spot price is considerably higher than in the Swedish and Norwegian price areas. The flows and prices go up and down, but when Olkiluoto 3 is operational and additional wind power is online it is likely that the spot prices go towards a Nordic equilibrium.

6.2.4 Wind power

Investing in wind power in Finland could be categorised into two outcomes depending on if the project will be included in the current FIT scheme or not. The FIT is the key driver for investing in Finland, especially since the winds are in general lower than in other Scandinavian countries. To estimate the investment opportunity time frame investors needs to estimate when the system will be full. As this will happen in a few years it is unsure exactly when, but interviews with industry professionals give indications that the actors on the market expect it to be filled up by 2018 - 2020. An analysis of the future pipeline by adding the project pipeline to the installed capacity of 885 MW in 2015 also estimates the system to be full by 2019; these two estimations are shown in figure 27. In Sweden the expansion from 0-6 TWh took 7-8 years and as the FIT-system was introduced in 2011 adding the Swedish development to the Finnish market also indicates that the subsidy system will be full by 2018-2019. The authors' estimation is therefore that the system will be full during the period 2018-2020 and most likely in 2019.

Project phase	Capacity [MW]	Operational by year
Preparing for construction	116	2016
Applying for permits	448	2017
EIA approved	106	2018
Under planning	2100	2019-2020

Table 12: Project pipeline with estimated time of commencing operations.

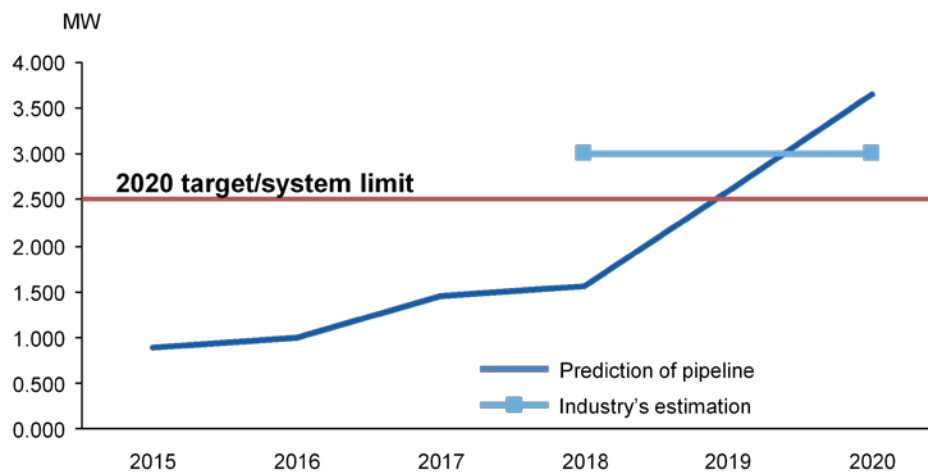


Figure 27: Estimation of when the FIT system is full.

The coming change in the subsidy system including a project with the quota decision rather than upon completion like today should decrease the business risks. However, as the quota decision could be decided when all necessary permits are acquired, there is a potential risk that developers get the quota decision without proper financing. So the FIT scheme may be filled up a few years before Finland has an installed wind capacity of 2500 MVA.

Analysing the pipeline further show that in the near future, a few large developers have a strong portfolio of projects while looking further ahead a more diversified group of actors are pursuing projects. There seem to have been a lag in construction, due to low growth in installed wind power since the introduction of the FIT. As all Finnish different stakeholders such as the ELYs and municipalities get experience from processing wind projects the efficiency in handling permit processes and EIAs will likely increase.

Once the FIT 2500 MVA quota is reached it is unclear if, and if so, what kind of subsidy scheme may be introduced to continue to support further expansion. Sources from the government reveals that there are quiet discussions about

what is next to come. Meanwhile, the politicians are avoiding the subject as much as possible. Minister of the Environment Niistiö do endorse wind power as a sustainable energy source, but leaves the subsidy discussion to the next government. This is a problematic way of handling the issue, and creates uncertainties for developers looking to invest in greenfield projects. As the process take years, most often between 5 and 7, it is unlikely that a new project today is to be included in the FIT system. This should cool down the market of greenfield projects and instead lead to investments in projects in later phases to ensure the tariff. So it should not be unlikely that a gap of expansion is to turn up from the time the developers feel sure that new projects will not make the current scheme and until they know what is to come.

The FIT is constructed to speed up the wind power expansion in the most beneficial way from both developers' and the government's standpoint. As the owner of a wind farm knows the price he or she will receive the next 12 years, the project risk decreases. Not the least as the electricity price has been lower than the tariff for quite some time. However the tariff does not adjust according to inflation, thus the attained tariff price nominally decreases over the 12 year period. As the inflation target is around 1.9 % the present value of the tariff is about 80 % of today's value. This is a driving incentive for developers to start producing as soon as possible due to the time value of money, which most likely was one of the government's purposes when introducing the system. Fast developers should be rewarded accordingly, an incentive which the even higher tariff until the end of 2015 shows.

The developers are counting on another subsidy system, but whereas to which extent is unclear. It is most likely that the scheme will not be as attractive as the FIT, which is related to EU legislation and the national political policies. Transferring tax payer Euros to international developers are a definite risk moment for the politicians and is likely to cause bad reputation amongst the citizens.

An option to a new Finnish system is that Finland is included in the current Swedish-Norwegian certificate system which is to run until 2035. The construction of the certificate system puts the cost of the market based system on the electricity customer instead of the government and thus the taxpayers as the current Finnish system does. For that reason the Swedish-Norwegian system might look interesting to the Finnish policy makers. On the other hand winds in Finland are the lowest in Scandinavia and that fundamental

difference would make it hard for wind power in Finland to compete with wind power in Sweden and Norway in the certificate system, as wind power projects in all countries would receive approximately the same electricity price and certificate price. A third option could be that all or many of the countries included in the Nordpool electricity market start a new common system as their electricity markets are highly integrated, which should stimulate wind power development where it is most economic viable.

The main transmission grid should be equipped to handle the increase in wind power as it is being developed, especially along the west coast. The future of each and every regional and distribution network is less clear but according to Fingrid the transmission capacity should be enough. More wind power comes with issues concerning the balance in the net, but as the Scandinavian grids are inter-connected problems with balance power should be relatively small. One factor that is in favour of Finland is its grid as it is deemed as one of the most capable in the world. Meanwhile, developers have encountered trouble with connecting to the grid claiming that it is tough to come to agreements with the network owners. This should however not be a big problem as Finnish grid owners are legally bound to connect new electricity production at a reasonable price.

The winds in Finland could be problematic as the Wind Atlas regularly shows winds of less than 7 m/s on the height of 100 meters. To counter this, the EIAs and permits are often for higher turbines, up to a rotor height of 140 meters and a total height of just over 200 meters. As mentioned earlier the wind is stronger at higher altitude, and as the quantitative analysis show the sweep area affects the predicted IRR. Sites with lower wind speeds can still be made viable through the use of high tower and big rotors sweeping a larger area even though the larger turbines are more expensive. A negative effect of the larger rotors is that they usually create more disturbing noise compared to smaller ones. With the new noise regulations due next year it can become harder to receive a permit for large turbines.

While Finland is a large country, there are almost 500 000 recreational houses scattered around the country side, to which the Finns go to relax. They are generally spread out, far from each other and puts constrains on the noise levels from wind power. The noise level of recreational housing is 35 dB, which is lower than regular housing. This fact greatly reduces the possible sites for wind power, and since the noise levels are under supervision even tighter constrains may be in effect within just a year. Some developers and the

national wind power association are very concerned and believe that several projects may be affected by it. It is likely that new regulations will hold back the expansion somewhat. One important issue is what will happen to attained permits and projects being tried if a lowering of the allowed noise levels becomes reality.

As Finland only has one offshore turbine sitting on an isle and as offshore is much more expansive than onshore it is not applicable in the current technology neutral subsidy system. Construction of a demonstration park with extra governmental support is soon to be started; by the time that will be finished the current subsidy system will likely be almost or completely full already. As the succeeding system is believed to be less generous and offshore is more expansive an expansion is unlikely.

6.2.5 The project-life cycle

Pursuing wind power projects in Finland are risky but if completed profits may lie ahead. The extensive timeframe from TGO until reaching phase six is a bumpy road full of pitfalls. All the different stakeholders with their own areas of interest deems compromising to finalise a wind farm.

Many projects are scrapped already in the first phase as close to no data about the found site is known at that time. It is easy to be overoptimistic in i.e. how many turbines that could be built, the actual wind speeds, or allowance for the height and rotor diameter of the turbines. There may also be challenges to convince the affected landowners to allow the developers to evaluate and possibly build on their grounds. It is imperative to humbly approach the neighbouring communities too, to gain their approval to pursue the project. The developers seem quite unanimous in the belief that if close neighbours are not on board, the project is doomed to fail from day one.

The planning phase is crucial as development costs are beginning to rise and that it could stretch out over a long period of time, especially if EIAs, permits, or zonings are being appealed. The EIA need statements from all different stakeholders affected by the project which could include ornithologists, hunters and archaeologists. Although many are positive, it seems to be common that some associations continuously argue against wind power due to its effects on the wildlife. The military is another stakeholder as radar and aviation are affected by the turbines. The military is a key player in Finland because of its east border towards Russia, not the least considering the Crimea conflict. Although the winds on the southeast coast of Finland are among the

best ones, no farms have yet been built even if there are developers trying to attain permits.

With the municipality in charge of the building permits it is in the interest of the developers that they keep all the proceeds from the property tax. It is a good incentive and is probably a small influence when deciding on building permits. Due to the less favourable economic situation in Finland it is however understandable that the federal government are considering to take half of the proceeds.

The tendering process does not differ much from tendering in other industries, but there are most likely some costs that could be cut. The WTG manufacturers sell the turbine, transportation, and erection as a bundle to the developers. It is likely more expensive for the developer to purchase it in a bundle, but depending on the experience of construction wind power it might also be a convenience. It is also less risky, as the turbine manufacturer coordinates all of the activities above and takes the overall responsibility for the delivery and erection. Due to the standardised way of tendering, this phase should not turn out to be much of a problem for the developer.

For the realisation phase to precede according to schedule it is important that all contractors deliver on time. A missed deadline could send a lag through the whole value chain. This is the only time were the developer wish for low winds to make the construction easier, but foul conditions could postpone the finalisation of a project by a substantial amount of time. In the northern areas the summer season during which casting and erection of tower can be done is only a few months. Small delays can cause a project to run out of time and be delayed one year.

During the generation the most crucial factor is the quality of the WTG, as a breakdown results in production loss and induces repair costs. It is difficult to appreciate the downtime of today's turbines as the development is fast and they are new on the market. The struggles with gearboxes breaking have led to the development of turbines with direct drives which are believed to be more robust and have fewer breakdowns. The depreciation of wind turbines could be both linear and digressive, this thesis have used the digressive way but depending on when during the lifetime a developer wants to show better results a linear depreciation rate may serve better.

6.3 Sensitivity analysis

Like previously stated in the beginning of a wind project many factors are uncertain for example; the exact wind speed on the site, on-site topography affecting the production output and construction cost, turbine prices, the electricity price and the O&M costs. In a longer time perspective during the operations phase, the electricity price and O&M costs are the most difficult to predict.

The electricity price will be the only source of income for 8 years or 40 % of the investments lifetime and will therefore have a large impact on the profitability of an investment. The reference project starting operations in 2015 will have the electricity price as its only income from 2027 onwards. The second reference project operational by 2020 will be solely dependent on the electricity price from 2031 and onwards. For both projects the dependency of the electricity price is far into the future and the further into the future prognosis are made the more uncertain they are.

Most turbines installed today were developed and introduced on the market recently, many of them are taller than the previous, and have higher effects or more advanced technology for example direct drive. Obviously none of them have been operational for the whole life time of 20 years yet.

The purpose of this sensitivity analysis was to point out the largest economic risks when investing in wind power in Finland. Investors need to make and use prognosis and estimations for these factors to be able to make capital investment calculations but are advised to carefully examine their prognosis and make them conservatively.

Another issue is the market risk given an average spot price of less than €30/MWh over a price period of 3 months. If this was to happen over a longer period, it would damage the owners' financial calculations greatly. Or if the spot price would drop and become negative, no revenues would be collected at all for such hours. The risk of a scenario like this must be taken into account, even if the predicted spot price is expected to never decrease enough to make these constraints affect the revenues.

7 Conclusions

The chapter sums up the business opportunities on the Finnish wind power market and deliver several factors to consider if a developer considers entering the market. The applicability and generalizability of the CL²-model is also further discussed.

The introduced CL²-model is an adequate model for assessing the attractiveness of one type of WDRES, wind power on a geographical market. The framework should be applied on markets for other WDRES and on other geographical markets and updated to make it applicable for these and thus generalizable. The process of using the framework to assess the wind power market in Finland was continuously validated by industry professionals and tweaked to fit the subject of analysis.

The case study of Finland conclude that there are viable business opportunities for actors whom are satisfied with an internal rate return of about 6.5 % over a 20 year period and whom believe that the wind power industry will stay unaffected from the current political and economic turbulence in Finland.

The conclusion is supported by the outcome of the questions formulated in the introduction. The FIT scheme supplies the developers with a quite safe and steady stream of revenue but does not follow the inflation thus decreasing the nominal revenue over time. The business case only shows viability due to the FIT scheme, which is predicted to be full by 2018-2019, thus eliminating the potential market entry through greenfield investment.

The political support seems sufficient, but there are risks to consider such as the recent governmental cut in welfare spending while the feed-in tariff is intact. There are most likely voters that would empathise with a party suggesting the opposite as an election promise for the 2015 elections. The new, possibly stricter, noise regulations that are to be introduced in January 2015 pose an additional uncertainty for a developer to consider. Entering the market is suggested after the decree has been published.

The reference project shows that the IRR of a project is closely correlated to when the farm is operational. Given a margin of error the quantitative evaluation show that Finland is interesting if the developer has a WACC allowing a return of at least 6.5 % and is willing to invest in brownfield projects and not initiate greenfield projects.

The longer term outlook for wind power is uncertain for several reasons. First the EU 2030 targets need to be decided and a new government elected in May 2015. When both of them are in place negotiations can be started. The target of 9 TWh by 2025 indicates that a new system should come but as the Finnish economy is weak a new system will likely be less generous than the current one. Most likely the new 2030 target will demand an even higher amount of renewable energy and since Finland cannot expand its hydropower this expansion will likely come in wind power.

Offshore wind power will likely not be expanded in Finland as it is more expensive than onshore and the construction of the demonstration park is soon to be started and will likely not be finished before the current system is full.

7.1 Investment recommended, but not risk free

A Finnish wind power investment is recommended for companies looking to receive a return on investment of about 6.5 %. As any investment the Finnish wind power market has its advantages and disadvantages, the main ones are listed below. An investment in the Finnish wind power market is recommended for the following reasons:

- Finland has a lucrative feed-in tariff system, target price € 83.5/ MWh for 12 years.
- Tall hub heights of 120-140 meters are allowed to compensate for low average wind speeds of 6.5-7.1 m/s at 100 m altitude.
- The installed Finnish wind capacity is expected to grow by more than 2 GW from 2014 to 2020.

The main disadvantages and risks are:

- Low average wind speeds.
- Political and economic turbulence that might cause a decrease in the FIT-tariff.
- The FIT-system is expected to be full by 2018-2019, leaving only a few years to acquire the needed permits.

7.2 Contribution

In this study the CL²-model, a new model for assessing the market attractiveness for renewable energy resources and more specific for weather dependent renewable resources has been developed. The model was applied to the specific geographic market of Finland and for one WDRES, namely

winds power. The study showed that the model worked well for wind power in Finland and thus will it most likely work well for assessing WDRES on other similar geographical countries like Finland's neighbours in the Nordic and northern Europe. Most likely can it also be applied on markets for other types of WDRES sharing the WDRES typical characteristics, for example; photovoltaic, solar thermal and other solar concentrated power resources.

Given the limitations and delimitations of the study, another contribution is the presentation of the complete picture of the wind power market in Finland. In the beginning of the study the authors estimated that the information gathering was to be rather straight forward, but as the study progressed the authors realised this not being the case. Therefore the information in the report is a contribution to academia and wind developers interested in wind power in Finland.

8 Final remarks

This chapter propose further research to develop the applicability and generalizability of the CL²-model.

8.1 Suggestions for further research

The study only applied the framework onto one particular WDRES and geographical market, on which it worked well. While the framework showed promise in the study, the next natural step would be to apply it to a broader spectrum of WDRES and geographical markets to achieve a higher **level** of generalizability. The CL²-model is also up for further improvement, for example how the qualitative evaluation is evaluated. It would be most beneficial to assess the qualitative evaluation by quantitative measures, especially if the user is to compare two different WDRES or geographical markets. The proposed improvement would advantageously be constructed through a survey where stakeholders on the market would rank different factors against each other. The result could then be turned into an evaluation model where qualitative factors would carry different weights in order to easier compare markets.

This study has solely investigated and analysed the Finnish wind power market and found that it looks attractive for investors with a certain level of return rate. It was not in the scoop of the study to compare the Finnish wind power market to other national wind power markets. The study showed that many of the actors on the Finnish wind power market are also present in other European markets. Thus before an international actor would decide to move into Finland they would most likely compare it to its home market or other markets. Thus a comparison of Finland and other European wind power markets is recommended for future studies.

8.2 General applicability of the results and model

The applicability and reliability of the results are highly related to the data used for an average Finnish wind projects and its costs. As especially the quantitative evaluation is based on assumptions, the reliability of this part is low. The assumptions are based on finding from in-depth interviews with industry professionals. The interviewees worked for different companies with various projects and since the cost of a project is dependent on the site and other factors the cost estimations varied. Through triangulation an average estimation was developed which increased the reliability.

As described in chapter 5.2 when a greenfield wind power project is started assumptions are made on wind speeds and onsite factors affecting the cost. As the project moves forward more accurate data is measured and acquired and the calculations become more correct. The foundation of wind power is the wind speed which is measure for one or sometimes a few years. Those results are then multiplied with the number of years the park is to be in operations to estimate the total production. Due to this and the uncertainties in the long term prognosis for the electricity price and O&M costs a wind power investment will always have to be based on some assumptions as the quantitative analysis in this study is.

As previously mentioned the chosen method of assessing an average wind power project was the most suitable approach for the assessment of the whole Finnish market. As written throughout the study regional differences affect the possibilities for wind power across Finland. For example the grid tariffs are set by the local grid owner, the distance to and the state of grid greatly affects the grid connection cost, the percentage for the property tax is set by municipalities and local opposition has stopped projects in the planning phase and appealed building permits in some municipalities. Therefore a developer needs to analyse the regional factors before deciding to invest in an area.

As companies' expectations on the rate of return varies with the type of owners and their expectations the result was made generalizable by presentation as an IRR indicating that for a company with a WACC lower than the IRR investing in wind power in Finland is viable.

References

Printed sources

Arbnor, I. & Bjerke, B., 2009. *Methodology for creating business knowledge*. 3rd ed. Thousand Oaks, California: Sage Publications.

Berk, J. & DeMarzo, P., 2011. *Corporate Finance*. 2:e ed. Harlow, Essex: Pearson.

Bertling Tjernberg, L. & Wennerhag, P., 2012. *Wind Turbine Operation and Maintenance Survey of the Development and Research Needs Elforsk report 12:41*, Stockholm: Elforsk.

Bingham, E. F. & Houston, J. F., 2009. *Fundamentals of Financial management*. 12th ed. Mason USA: Cengage learning.

Couture, T. & Gagnon, Y., 2009. An analysis of feed-in tariff remuneration models: Implications for renewable energy investments. *Energy Policy*, Volume 38, p. 955–965.

Denscombe, M., 2009. *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna*. 2:7 ed. Lund: Studentlitteratur AB.

EIA, 2013. *Annual Energy Outlook 2013 - with projections to 2040*, Washington DC: US. Department of Energy.

EWEA, 2002. *Wind energy- the facts volume 2 costs & prices*, Brussels: EWEA.

Finland's Ministry of Employment and the Economy, 2013b. *Finansministeriets förordning om grunder för återanskaffningsvärdet av byggnader*. Helsingfors: Finlands författningssamling.

Fontana, J., Warren, B. & Rennie, M., 2012. Keeping the capital flowing for renewable energy. *Utilities Unbundled*, June(Issue 12), pp. 12-22.

Hill, T. & Westbrook, R., 1997. SWOT Analysis: It's Time for a Product Recall. *Long Range Planning*, 30(1), pp. 46-52.

Höst, M., Regnell, B. & Runeson, P., 2006. *Att genomföra examensarbete*. 1:6 ed. Lund: Studentlitteratur AB.

Johnson, G., Scholes, K. & Whittington, R., 2009. *Fundamentals of Strategy*. 1st ed. Essex: Pearson Education Limited.

Lekvall, P. & Wahlbin, C., 2001. *Information för marknadsföringsbeslut*. 4th ed. Gothenburg: IHM Publishing.

Manwell, J., McGowan, J. & Rogers, A., 2009. *Wind Energy Explained: Theory, Design and Application*. 2nd ed. Wiley, Hoboken: John Wiley & Sons Ltd.

Ministry of Justice , 1995. *FFS 468 Lag om förfarandet vid miljökonsekvensbedömning*. Helsinki: Ministry of Justice.

Ministry of Justice, 2006. *FFS 713 Statsrådets förordning om förfarandet vid miljökonsekvensbedömning*. Helsinki: Ministry of Justice.

Ministry of Justice, 2010a. *FFS 1396: Lag om stöd till produktion av el från förnybara energikällor*. Helsinki: Ministry of Justice.

Ministry of Justice, 2010b. *FFS 1397: Statsrådets förordning om stöd till produktion av el från förnybara energikällor*. Helsinki: Ministry of Justice.

Ministry of Justice, 2013. *FFS 490 Lag om kompensationsområde för vindkraft*. Helsinki: Ministry of Justice.

Ministry of the environment, 2012. *Planering av vindkraftsutbyggnad*, Helsinki: Miljöministeriet.

Obernberger, I. & Thek, G., 2008. *Combustion and gasification of solid biomass for heat and power production in Europe - State-of-the-art and relevant future developments*, Vilamoura, Portugal: Cenertec.

Porter, M. E., 1998. *Competitive strategy: techniques for analyzing industries and competitors: with an introduction*. New York: Free press.

Porter, M. E., 2008. The five competitive forces that shape strategy. *Harvard Business Review*, Issue January, pp. 78-86.

Pratt, S. P. & Grabowski, R. J., 2010. *Cost of Capital: Applications and Examples*. 4th ed. Hoboken : John Wiley & Sons, Inc.,.

PwC, 2013. *Project X*, s.l.: N/A.

Rosengren, K. E. & Arvidson, P., 2002. *Sociologisk metodik*. 5th ed. Malmö: Liber.

Rothbauer, P., 2008. Triangulation. In: L. M. Given, ed. *The SAGE Encyclopedia of Qualitative Research Methods*. Thousand Oaks(CA): SAGE Publications, Inc, pp. 893-895.

SEB Economic Research, 2014a. *Nordic Outlook - February 2014*, Stockholm: SEB.

SEB Economic Research, 2014b. *Nordic Outlook - May 2014*, Stockholm: SEB.

Sitra, 2007. *Cleantech Finland - improving the environment through business*, Helsinki: Sitra.

Sovacool, B., 2008. Valuing the greenhouse gas emissions from nuclear power: A critical survey. *Energy Policy*, Issue 36, pp. 2940-2953.

The Energy Authority, 2014g. *Advanced notifications 2014*, Helsinki: The Energy Authority.

The Energy Authority, 2014h. *Advanced notifications 2015*, Helsinki: The Energy Authority.

Transparency International, 2013. *Corruption Perceptions Index 2013*, Berlin: Transparency International.

Vernimmen, P., 2006. *Corporate Finance*. Chichester: Wiley.

von Bremen, L., 2010. Large-scale variability of weather dependent renewable energy sources. In: A. Troccoli, ed. *Management of Weather and Climate Risk in the Energy Industry*. Dordrecht: Springer Science & Business Media B.V., pp. 189-206.

Wizelius, T., 2002. *Vindkraft i teori och praktik*. 1 ed. Lund: Studentlitteratur.

Work document, x., 2014. *Work document*. Stockholm: N/A.

Internet sources

Bach, T. et al., 2013. *Extra, extra! Read our COP19 wrap-up in the Huffington Post!*. [Online]

Available at: <http://vlscop.vermontlaw.edu/2013/12/02/extra-extra-read-our-cop19-wrap-up-in-the-huffington-post/>

[Accessed 04 04 2014].

Bank of Finland, 2014. *Bank of Finland*. [Online]

Available at:

http://www.suomenpankki.fi/sv/suomen_pankki/Pages/default.aspx

[Accessed 07 04 2014].

Bloomberg , 2012. *Overcapacity and new players keep wind turbine prices in the doldrums*. [Online]

Available at: <http://www.newenergyfinance.com/PressReleases/view/196>

[Accessed 22 04 2014].

Bloomberg , 2014. *EU Russian-Gas Cut Bid Amid Ukraine Crisis Sidelines Climate*. [Online]

Available at: <http://www.bloomberg.com/news/2014-03-21/eu-bid-to-cut-russian-gas-amid-ukraine-crisis-sidelines-climate.html>

[Accessed 02 06 2014].

Bloomberg Businessweek, 2014. *China Wind Turbine Makers Face Consolidation as Glut Lingers*. [Online]

Available at: <http://www.businessweek.com/news/2014-04-17/china-s-wind-turbine-makers-face-consolidation-as-glut-lingers>

[Accessed 22 04 2014].

Bloomberg, 2014. *Finnish Finance Minister Ousted as Party Head Over Austerity*. [Online]

Available at: <http://www.bloomberg.com/news/2014-05-08/finland-s-urpilainen-faces-party-revolt-over-austerity-policies.html>

[Accessed 16 05 2014].

Centre for Economic Development, Transport and the Environment, 2014. *Centre for Economic Development, Transport and the Environment*. [Online]

Available at: <http://www.ely-keskus.fi/en/web/ely-en/>

[Accessed 12 03 2014].

Communication 18 Ventures, 2014a. *Political Pestel Analysis Tool*. [Online]

Available at: <http://pestel-analysis.com/content/political-pestel-analysis-tool>

[Accessed 11 02 2014].

Communication 18 Ventures, 2014b. *Economic Pestel Analysis Tool*. [Online]

Available at: <http://pestel-analysis.com/content/economic-pestel-analysis-tool>

[Accessed 11 02 2014].

Communication 18 Ventures, 2014c. *Social Pestel Analysis Tool*. [Online]
Available at: <http://pestel-analysis.com/content/social-pestel-analysis-tool>
[Accessed 11 02 2014].

Communication 18 Ventures, 2014d. *Technical Pestel Analysis Tool*. [Online]
Available at: <http://pestel-analysis.com/content/technical-pestel-analysis-tool>
[Accessed 11 02 2014].

Communication 18 Ventures, 2014e. *Environmental Pestel Analysis Tool*. [Online]
Available at: <http://pestel-analysis.com/content/environmental-pestel-analysis-tool>
[Accessed 11 02 2014].

Conca, J., 2014. *Nukes Best Option Against Russian Gas*. [Online]
Available at: http://www.forbes.com/sites/jamesconca/2014/04/14/nukes-best-option-against-russian-gas/#./?&_suid=139927509223808528790209562642
[Accessed 05 05 2014].

Easton, a., 2014. *Poland and Baltics feel heat from Crimea*. [Online]
Available at: <http://www.bbc.com/news/world-europe-26526053>
[Accessed 10 04 2014].

Embassy of Finland, 2014. *Debatt i Finland 13/2014*. [Online]
Available at:
<http://www.finlande.ma/public/default.aspx?contentid=302727&nodeid=37965&contentlan=3&culture=sv-FI>
[Accessed 16 05 2014].

ENTSO-E, 2013. *Reliable. Sustainable. Connected.* [Online]
Available at: <https://www.entsoe.eu/about-entso-e/inside-entso-e/mission-and-vision/>
[Accessed 13 03 2014].

EOLE-RES, 2014. *Solar energy*. [Online]
Available at: <http://www.eoleres.com/en/what-we-do/solar-energy.aspx#>
[Accessed 28 03 2014].

European Central Bank, 2014. *Monetary Policy*. [Online]
Available at: <http://www.ecb.europa.eu/mopo/html/index.en.html>
[Accessed 13 05 2014].

European Commission, 2014a. *The 2020 climate and energy package*. [Online]
Available at: <http://ec.europa.eu/clima/policies/package/>
[Accessed 26 02 2014].

European Commission, 2014b. *Finland - From recession to gradual recovery*.
[Online]
Available at:
http://ec.europa.eu/economy_finance/eu/forecasts/2014_spring/fi_en.pdf
[Accessed 13 05 2014].

European Parliament, 2014. *2013/2135(INI) - 05/02/2014 Text adopted by Parliament, single reading*. [Online]
Available at:
<http://www.europarl.europa.eu/oeil/popups/printsummary.pdf?id=1336401&l=en&t=E>
[Accessed 26 02 2014].

Eurostat, 2014. *Renewable energy in the EU28 Share of renewables in energy consumption up*. [Online]
Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/8-10032014-AP/EN/8-10032014-AP-EN.PDF
[Accessed 29 05 2014].

EWEA, 2009. *The Economics of Wind Energy- A report by the European Wind Energy Association*. [Online]
Available at:
http://www.ewea.org/fileadmin/ewea_documents/documents/00_POLICY_document/Economics_of_Wind_Energy_March_2009.pdf
[Accessed 14 03 2014].

EWT, 2014. *Direct drive technology*. [Online]
Available at: <http://www.ewtdirectwind.com/technology/direct-drive-technology.html>
[Accessed 24 04 2014].

FCG Design och planering Ab, 2013. *Delgeneralplan för Kalax*. [Online]
Available at:

http://www.narpes.fi/sites/default/files/narpes/files/bygga_bo/pdb_kalax_v_indkraftpark.pdf

[Accessed 21 04 2014].

Fennovoima, 2014. *Greenfield project Hanhikivi 1*. [Online]

Available at: <http://www.fennovoima.com/en/hanhikivi-1-project>

[Accessed 03 03 2014].

Financial Times, 2012. *Vestas investors seek wind of change*. [Online]

Available at: <http://www.ft.com/cms/s/0/f4622308-f4dc-11e1-b120-00144feabdc0.html#axzz2zcZtdrli>

[Accessed 22 04 2014].

Fingrid, 2013. *National ten-year grid development plan for Finland*. [Online]

Available at:

[http://www.fingrid.fi/en/grid_projects/Transmission%20lines%20and%20maintenance%20attachments/National ten-year grid development plan Finland2012.pdf](http://www.fingrid.fi/en/grid_projects/Transmission%20lines%20and%20maintenance%20attachments/National_ten-year_grid_development_plan_Finland2012.pdf)

[Accessed 05 05 2014].

Fingrid, 2014a. *State of the Nordic Power System*. [Online]

Available at: <http://www.fingrid.fi/en/electricity-market/power-system/Pages/State-of-the-Nordic-Power-System.aspx>

[Accessed 03 03 2014].

Fingrid, 2014b. *Fingrid. Powering Finland..* [Online]

Available at:

<http://www.fingrid.fi/en/company/company/Pages/default.aspx>

[Accessed 12 03 2014].

Fingrid, 2014c. *Power Transmission Grid*. [Online]

Available at:

<http://www.fingrid.fi/en/company/company/PowerTransmissionGrid/Pages/default.aspx>

[Accessed 13 03 2014].

Fingrid, 2014d. *Grid service fees*. [Online]

Available at:

<http://www.fingrid.fi/en/customers/grid%20service/fees/Pages/default.aspx>

x

[Accessed 21 03 2014].

Fingrid, 2014e. *Connection fees*. [Online]

Available at:

<http://www.fingrid.fi/en/customers/connection/connectionfees/Pages/default.aspx>

[Accessed 21 03 2014].

Finland's Ministry of Employment and the Economy, 2013. *Strategy 2013*.

[Online]

Available at: http://www.tem.fi/files/36292/Energia-ja_ilmastostrategia_netijulkaisu_ENGLANNINKIELINEN.pdf

[Accessed 31 01 2014].

Finland's Ministry of Employment and the Economy, 2014. *Electricity market*.

[Online]

Available at: http://www.tem.fi/en/energy/electricity_market

[Accessed 12 03 2014].

Finlex, 2005. *Lag om värdering av tillgångar vid beskattningen (30 §)*. [Online]

Available at:

<http://www.finlex.fi/sv/laki/ajantasa/2005/20051142?search%5Btype%5D=pika&search%5Bpika%5D=lag%20om%20v%C3%A4rdering%20av%20tillg%C3%A5ngar%20vid%20beskattning>

[Accessed 24 03 2014].

Finnish Energy Industries, 2010. *Network Structure*. [Online]

Available at: <http://energia.fi/en/electricity-market/electricity-network/network-structure>

[Accessed 21 03 2014].

Finnish Energy Industries, 2012. *Finnish energy attitudes 2012*. [Online]

Available at: <http://energia.fi/en/publications/finnish-energy-attitudes-2012>

[Accessed 20 04 2014].

Finnish Energy Industries, 2013. *Electricity production, imports and exports*.

[Online]

Available at: <http://energia.fi/en/statistics-and-publications/electricity-statistics/production/production-imports-and-exports>

[Accessed 03 03 2014].

Finnish Government, 2014. *Prime Minister Katainen's Government*. [Online]
Available at: <http://valtioneuvosto.fi/hallitus/en.jsp>
[Accessed 16 05 2014].

Finnish Wind Atlas, 2009a. *Vindpotentialen i Finland*. [Online]
Available at: <http://www.windatlas.fi/vindpotentialen/index.html>
[Accessed 03 03 2014].

Finnish Wind Atlas, 2009b. *Finnish Wind Atlas*. [Online]
Available at: <http://tuuliatlas.fmi.fi/en/>
[Accessed 28 02 2014].

Finnish Wind Atlas, 2009c. *Wind Atlas - wind energy resources on the map of Finland*. [Online]
Available at: <http://www.windatlas.fi/en/index.html>
[Accessed 28 02 2014].

Finnish Wind Atlas, 2009d. *Reference period*. [Online]
Available at: http://www.windatlas.fi/modelling/mallinnus_7.html
[Accessed 28 02 2014].

Finnish Wind Atlas, 2009e. *Finnish Icing Atlas*. [Online]
Available at: <http://www.windatlas.fi/icingatlas/index.html>
[Accessed 28 02 2014].

Finnish Wind Atlas, 2009f. *Maps of power production*. [Online]
Available at: <http://www.windatlas.fi/powerproduction/index.html>
[Accessed 28 02 2014].

Finnish Wind Atlas, 2009g. *Variation in wind speed*. [Online]
Available at: http://www.windatlas.fi/windspeed/windspeed_1.html
[Accessed 13 03 2014].

Fortum, 2009. *Loviisa Power Plant*. [Online]
Available at:
http://www.fortum.com/SiteCollectionDocuments/Energy%20production/105-powerplant_eng.pdf
[Accessed 03 03 2014].

Fortum, 2013. *Prislista för tjänster i regionnät*. [Online]
Available at:
<http://www.fortum.com/countries/fi/SiteCollectionDocuments/Sahkon->

siirto-ja-liittymat/Verkkopalvelu-%20ja%20liittymismaksuhinnasto%20alueverkossa 1.1.2013 se.pdf
[Accessed 22 05 2014].

Fortum, 2014. *Fortum - Power and heat company in the Nordic area, Russia, Poland and the Baltics*. [Online]
Available at:
[http://apps.fortum.fi/gallery/Fortum investor material February 2014.pdf](http://apps.fortum.fi/gallery/Fortum_investor_material_February_2014.pdf)
[Accessed 12 03 2014].

Gupta, R., 2014. *End of warranty handover: how to ease impacts on profitability*. [Online]
Available at: <http://social.windenergyupdate.com/operations-maintenance/end-warranty-handover-how-ease-impacts-profitability>
[Accessed 23 04 2014].

Helsinki Times, 2014. *Finland mulls cuts to municipalities' tax revenue from wind farms*. [Online]
Available at: <http://www.helsinkitimes.fi/finland/finland-news/domestic/9431-finland-mulls-cuts-to-tax-revenue-from-wind-farms.html>
[Accessed 21 04 2014].

How-to-start-a-business-guide.com, 2009. *SWOT Analysis for Your Startup Business*. [Online]
Available at: <http://www.how-to-start-a-business-guide.com/SWOT-analysis.html>
[Accessed 12 02 2014].

IEA Wind, 2011. *IEA wind Work package 1 final report*. [Online]
Available at:
https://www.ieawind.org/index_page_postings/task26/task%2026%20wp%201%20report.pdf
[Accessed 27 03 2014].

IEA, 2013. *IEA wind annual report 2012 Finland*. [Online]
Available at:
https://www.ieawind.org/annual_reports_PDF/2012/Finland.pdf
[Accessed 22 04 2014].

Impax asset management, 2014. *About us*. [Online]
Available at: <http://www.impaxam.com/about-us>
[Accessed 22 04 2014].

locations4business, 2013. *Finland*. [Online]
Available at: <http://www.locations4business.com/europe/finland/>
[Accessed 07 04 2014].

Markedskraft, 2012. *Long Term Expectations for the price development in the Nordic Power Market 2013-2035*. [Online]
Available at:
http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&ved=0CDUQFjAB&url=http%3A%2F%2Fpolyteknisk.no%2Fcontent%2Fdownload%2F35862%2F216731%2Fversion%2F1%2Ffile%2FOlav%2BJohan%2BBotnen.pdf&ei=E7RrU4viNIG6ygP_iYDwAg&usg=AFQjCNE4zKV4eil3GcQOifa
[Accessed 08 05 2014].

Mikkonen, A., 2013. *Tuulivoimahankkeet - Wind power Projects*. [Online]
Available at: <http://www.tuulivoimayhdistys.fi/hankkeet>
[Accessed 01 03 2014].

Milborrow, D., 2010. *Breaking down the cost of wind turbine maintenance*. [Online]
Available at:
<http://www.windpowermonthly.com/article/1010136/breaking-down-cost-wind-turbine-maintenance>
[Accessed 23 04 2014].

Mind Tools, 2014a. *PEST Analysis*. [Online]
Available at: http://www.mindtools.com/pages/article/newTMC_09.htm
[Accessed 11 02 2014].

Mind Tools, 2014b. *SWOT Analysis*. [Online]
Available at: http://www.mindtools.com/pages/article/newTMC_05.htm
[Accessed 11 02 2014].

Mind Tools, 2014c. *Press Release*. [Online]
Available at: <http://www.mindtools.com/QueensAward.htm>
[Accessed 28 5 2014].

Ministry of employment and the economy, 2012. *Tarastis utredning om främjande av vindkraften tar upp problemen kring vindkraft*. [Online]
Available at: http://www.tem.fi/sv/aktuellt/meddelanden/meddelandearkivet/ar_2012/tarastis_utredning_om_framjande_av_vindkraften_tar_upp_problemen_kring_vindkraft.106231.news
[Accessed 21 04 2014].

Ministry of the environment, 2013c. *Changes in legislation to promote wind power*. [Online]
Available at: [http://www.ym.fi/en-US/Latest_news/Press_releases/Press_releases_2013/Changes_in_legislation_to_promote_wind_p\(24995\)](http://www.ym.fi/en-US/Latest_news/Press_releases/Press_releases_2013/Changes_in_legislation_to_promote_wind_p(24995))
[Accessed 08 05 2014].

Modern Utility Management, 2013. *Generating success*. [Online]
Available at: <http://www.modernutilitymanagement.com/article-page.php?contentid=17852&channelid=262&issueid=496>
[Accessed 06 05 2014].

Nikula, K., 2014. *Tietoa meistä*. [Online]
Available at: <http://tvky.info/tietoa-meista/>
[Accessed 29 04 2014].

Nord Pool Spot, 2014a. *About us*. [Online]
Available at: <http://www.nordpoolspot.com/About-us/>
[Accessed 03 03 2014].

Nord Pool Spot, 2014b. *Elsport prices*. [Online]
Available at: <http://www.nordpoolspot.com/Market-data1/Elsport/Area-Prices/ALL1/Hourly/>
[Accessed 08 05 2014].

Nord Pool Spot, 2014b. *Elsport prices*. [Online]
Available at: <http://www.nordpoolspot.com/Market-data1/Elsport/Area-Prices/ALL1/Hourly/>
[Accessed 08 05 2014].

O2, 2013a. *O2 Annual report 2012*. [Online]
Available at: <http://www.o2.se/wp->

[content/uploads/2013/05/O2_AR_2012_eng_8maj_web.pdf](#)

[Accessed 12 03 2014].

O2, 2013b. *Information till markägare*. [Online]

Available at: <http://www.o2.se/wp-content/uploads/2013/09/O2-Broschyr-Markägare-SV-10.9.2013.pdf>

[Accessed 12 03 2014].

O2, 2013c. *Hur mycket får jag i markarrende?*. [Online]

Available at: <http://www.o2.se/wp-content/uploads/2013/08/Arrende-infoblad-SV-18.7.2013-PDF.pdf>

[Accessed 12 03 2014].

OECD, 2014. *Trade in Finland*. [Online]

Available at: <http://atlas.media.mit.edu/profile/country/fin/>

[Accessed 10 04 2014].

Official Statistics of Finland (OSF), 2013. *Energy supply and consumption 2012*. [Online]

Available at: http://tilastokeskus.fi/til/ehk/2012/ehk_2012_2013-12-12_en.pdf

[Accessed 03 03 2014].

Official Statistics of Finland (OSF), 2013. *Share of renewable energy sources in production of electricity and heat grew in 2012*. [Online]

Available at: http://www.stat.fi/til/salatuo/2012/salatuo_2012_2013-11-05_en.pdf

[Accessed 31 01 2014].

Official Statistics of Finland (OSF), 2014a. *Energy supply and consumption [e-publication]*. [Online]

Available at: http://tilastokeskus.fi/til/ehk/2013/04/ehk_2013_04_2014-03-24_tie_001_en.html

[Accessed 31 03 2014].

Official Statistics of Finland (OSF), 2014b. *Trend Indicator of Output [e-publication]*. [Online]

Available at:

http://www.tilastokeskus.fi/til/ktkk/2014/03/ktkk_2014_03_2014-05-15_tie_001_en.html

[Accessed 16 05 2014].

PRI, 2013. *Spanish government plan takes wind out of sails of country's renewable energy sector*. [Online]
Available at: <http://www.pri.org/stories/2013-07-08/spanish-government-plan-takes-wind-out-sails-countrys-renewable-energy-sector>
[Accessed 08 04 2014].

Puhuri Oy, 2014. *Puhuri*. [Online]
Available at: <http://www.puhuri.fi/frontpage.html>
[Accessed 06 05 2014].

Rajakiiri, 2014. *Rajakiiri Oy - ett finländskt vindkraftsbolag*. [Online]
Available at: <http://www.rajakiiri.fi/sv/>
[Accessed 06 05 2014].

Reuters, 2014. *Left party to exit Finland's government over budget cuts*. [Online]
Available at: <http://www.reuters.com/article/2014/03/25/us-finland-government-leftalliance-idUSBREA201QK20140325>
[Accessed 16 05 2014].

Seabased, 2013a. *Tillstånd för anläggningar*. [Online]
Available at: <http://www.seabased.com/sv/teknologi/tillstand-for-anlaggningar>
[Accessed 28 03 2014].

Seabased, 2013b. *Kompletta anläggningar*. [Online]
Available at: <http://www.seabased.com/sv/teknologi/kompletta-anlaggningar>
[Accessed 28 03 2014].

Semcon, 2011. *Semcon lanserar nästa generations projektmetodik, XLPM*. [Online]
Available at: <http://news.cision.com/se/semcon/r/semcon-lanserar-nasta-generations-projektmetodik--xlpm,c540337>
[Accessed 26 03 2014].

Semcon, 2014. *XLPM*. [Online]
Available at: <https://xlpm-online.com/se>
[Accessed 27 03 2014].

- S-Kanava, 2014a. *S-ryhmän rakenne*. [Online]
Available at: <https://www.s-kanava.fi/web/s/s-ryhma/s-ryhman-rakenne>
[Accessed 06 05 2014].
- S-Kanava, 2014b. *TuuliWatti rakentaa suurtuulipuiston Kalajoelle*. [Online]
Available at: https://www.s-kanava.fi/uutinen/tuuliwatti-rakentaa-suurtuulipuiston-kalajoelle/1137890_384136
[Accessed 06 05 2014].
- Skog, S.-S., 2011. *SODAR-vindmätningar*. [Online]
Available at: <http://bloggen.fi/medvind/2011/11/14/sodar-vindmatningar/>
[Accessed 13 03 2014].
- Solidium, 2014a. *Mission and operation*. [Online]
Available at: http://www.solidium.fi/about_solidium/mission_and_operation
[Accessed 07 04 2014].
- Solidium, 2014b. *Portfolio*. [Online]
Available at: <http://www.solidium.fi/investments/portfolio>
[Accessed 07 04 2014].
- Solidium, 2014. *Successful placement by Solidium of Sampo A-shares and bonds exchangeable into Sampo A-shares due 2018*. [Online]
Available at:
[http://www.solidium.fi/publications_and_media/press_releases/press_releases/t=successful-placement-by-solidium/id=54429733](http://www.solidium.fi/publications_and_media/press_releases/press_release/t=successful-placement-by-solidium/id=54429733)
[Accessed 07 04 2014].
- ST1, 2014. *ST1 In brief*. [Online]
Available at: <http://www.st1.eu/st1-in-brief>
[Accessed 06 05 2014].
- Staalesen, A., 2014. *Finland gains independence from Russian gas*. [Online]
Available at: <http://barentsobserver.com/en/energy/2014/03/finland-gains-independence-russian-gas-04-03>
[Accessed 10 04 2014].
- Statistikcentralen, 2007. *Energianvändningen och energikällorna 1917-2007*. [Online]
Available at: http://www.stat.fi/tup/suomi90/maaliskuu_sv.html
[Accessed 03 03 2014].

Statistikcentralen, 2012. *Energistatistik 2012*. [Online]

Available at:

http://pxweb2.stat.fi/sahkoiset_julkaisut/energia2012/data/t03_06.xls
[Accessed 04 03 2014].

Svenska Yle, 2014. *Mindre skatt för kommuner med vindkraft*. [Online]

Available at: <http://svenska.yle.fi/artikel/2014/02/21/mindre-skatt-kommuner-med-vindkraft>

[Accessed 21 04 2014].

Sveriges Riksbank, 2011. *The inflation target*. [Online]

Available at: <http://www.riksbank.se/en/Monetary-policy/Inflation/Adoption-of-the-inflation-target/>

[Accessed 27 03 2014].

SVT Nyheter, 2014. *Svenskt stöd till grön el kan gå till utlandet*. [Online]

Available at: <http://www.svt.se/nyheter/sverige/svenskt-stod-till-gron-el-kan-ga-till-utlandet>

[Accessed 22 05 2014].

Taaleritehdas, 2013. *Kuvia Tuuliturbinien Matkasta*. [Online]

Available at: <http://www.taaleritehdas.fi/fi/campaign/kuvia-tuuliturbiinien-matkasta.html>

[Accessed 06 05 2014].

Taaleritehdas, 2014. *Wind power*. [Online]

Available at: <http://www.taaleritehdas.fi/en/wind-power.html>

[Accessed 23 04 2014].

The Daily Caller, 2014. *Spain ends subsidies to nearly 40 percent of its wind energy capacity*. [Online]

Available at: <http://dailycaller.com/2014/02/07/spain-ends-subsidies-to-nearly-40-percent-of-its-wind-energy-capacity/>

[Accessed 02 06 2014].

The Energy Authority, 2013. *Vuosikertomus - Årsberättelse 2012*. [Online]

Available at:

http://www.energiavirasto.fi/documents/10179/0/Vuosikertomus_2012a.pdf/11315896-d42c-4b90-a8b8-c5860d43cb02?version=1.0

[Accessed 03 03 2014].

The Energy Authority, 2014a. *Energy Authority*. [Online]
Available at: <http://www.energiavirasto.fi/en/web/energy-authority/energy-authority>
[Accessed 12 03 2014].

The Energy Authority, 2014b. *Renewable Energy*. [Online]
Available at: <http://www.energiavirasto.fi/en/web/energy-authority/renewable-energy>
[Accessed 26 02 2014].

The Energy Authority, 2014c. *Utbetalning av inmatningspris*. [Online]
Available at: <http://www.energiavirasto.fi/syottotariffin-maksatus>
[Accessed 27 02 2014].

The Energy Authority, 2014d. *Applications and notifications*. [Online]
Available at: <http://www.energiavirasto.fi/en/web/energy-authority/applications-and-notifications>
[Accessed 27 02 2014].

The Energy Authority, 2014e. *Sähköverkon haltijat*. [Online]
Available at: <http://www.energiavirasto.fi/sv/sahkoverkon-haltijat>
[Accessed 05 05 2014].

The Energy Authority, 2014f. *Kontrollörer och verifiering*. [Online]
Available at: <http://www.energiavirasto.fi/sv/todentajat-ja-varmentaminen>
[Accessed 24 04 2014].

The Energy Authority, 2014g. *Uppgifter om kraftverk som har godkänts för systemet med inmatningspris*. [Online]
Available at: <https://tuotantotuki.emvi.fi/Installations>
[Accessed 05 05 2014].

The Finnish Windpower Association, 2013. *Tuulivoimahankkeet - Wind power Projects*. [Online]
Available at: <http://www.tuulivoimayhdistys.fi/hankkeet>
[Accessed 05 05 2014].

The Guardian, 2014. *Hillary Clinton says Vladimir Putin's Crimea occupation echoes Hitler*. [Online]
Available at: <http://www.theguardian.com/world/2014/mar/06/hillary->

clinton-says-vladimir-putins-crimea-occupation-echoes-hitler
[Accessed 10 04 2014].

thisisFINLAND, 2014. *Finland in facts*. [Online]
Available at:
<http://finland.fi/Public/default.aspx?contentid=160032&nodeid=44491&culture=en-US>
[Accessed 07 04 2014].

Trafikverket, 2012. *Trafikverkets anvisning om vindkraft (Tuulivoimalaohje, Trafikverkets anvisningar 8/2012)*. [Online]
Available at: <http://www.ym.fi/download/noname/%7B6060DC1B-0ED0-4CE9-A822-576BD69FA7E3%7D/59831http://www.ymparisto.fi/download/noname/%7B90AD0258-A86D-426A-BDB0-AE0B723137E5%7D/96260>
[Accessed 12 3 2014].

TuuliWatti, 2014. *Tuulivoimatuotanto*. [Online]
Available at: <http://www.tuuliwatti.fi/index.php?id=12187>
[Accessed 06 05 2014].

UNFCCC, 2014a. *Kyoto Protocol*. [Online]
Available at: http://unfccc.int/kyoto_protocol/items/2830.php
[Accessed 04 04 2014].

UNFCCC, 2014b. *Status of Ratification of the Kyoto Protocol*. [Online]
Available at:
http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php
[Accessed 04 04 2014].

Utrikesministeriet, 2011. *Finlands väg till EU-medlemskap*. [Online]
Available at:
<http://eurooppatiedotus.fi/public/?contentid=92693&contentlan=3&culture=sv-FI>
[Accessed 07 04 2014].

Vaisala, 2014. *Wind Resource Assessment*. [Online]
Available at:
<http://www.vaisala.com/en/energy/powergeneration/windresourceassessment/Pages/default.aspx?kk=wind%20power&kt=de08d5a8-2870-4820->

[93bf-dd0d4ba847ca&gclid=C1bZmPDh8b0CFcHUcgodfDoAvA](https://www.vero.fi/sv-FI/93bf-dd0d4ba847ca&gclid=C1bZmPDh8b0CFcHUcgodfDoAvA)
[Accessed 23 04 2014].

Vero, 2014a. *Tillämpningsanvisning för fastighetsskattelagen*. [Online]
Available at: [https://www.vero.fi/sv-FI/Detailerade_skatteanvisningar/Fastighetsbeskattning/Tillampningsanvisning_for_fastighetsskat\(30893\)](https://www.vero.fi/sv-FI/Detailerade_skatteanvisningar/Fastighetsbeskattning/Tillampningsanvisning_for_fastighetsskat(30893))
[Accessed 23 04 2014].

Vero, 2014b. *Inkomstbeskattning – aktiebolag och andelslag*. [Online]
Available at: http://www.vero.fi/sv-FI/Foretags_och_samfundskunder/Aktiebolag_och_andelslag/Inkomstbeskattning
[Accessed 23 04 2014].

Vindkraftsnyheter.se, 2011. *Gothia Vind startar vindmätningar*. [Online]
Available at: <http://www.vindkraftsnyheter.se/2011/08/gothia-vind-startar-vindm-tningar>
[Accessed 13 03 2013].

Virta, I., 2014. *Talouselämän tutkimus: Kansa tyrmää lisäydinvoiman*. [Online]
Available at:
<http://www.talouselama.fi/uutiset/talouselaman+tutkimus+kansa+tyrmaa+lisaydinvoiman/a2236551>
[Accessed 29 04 2014].

Wallén, M., 2014. *Därför tvingas Finland dumpa aktier*. [Online]
Available at: <http://www.di.se/#!/artiklar/2014/2/25/darfor-tvingas-finland-dumpa-aktier/>
[Accessed 07 04 2014].

Wikipedia, 2014. *Cost of electricity by source*. [Online]
Available at: http://en.wikipedia.org/wiki/Cost_of_electricity_by_source
[Accessed 04 06 2014].

Wind measurement international, 2014. *Operational and Maintenance Costs for Wind Turbines*. [Online]
Available at: <http://www.windmeasurementinternational.com/wind-turbines/om-turbines.php>
[Accessed 23 04 2014].

Wind Power Monthly, 2013. *Vestas reveals de-icing system*. [Online]
Available at: <http://www.windpowermonthly.com/article/1217693/vestas-reveals-de-icing-system>
[Accessed 05 05 2014].

Wind Power Monthly, 2014. *Gamesa to launch nonnotech de-icing solution*. [Online]
Available at: <http://www.windpowermonthly.com/article/1288374/gamesa-launch-nanotech-de-icing-solution>
[Accessed 06 05 2014].

WinWinD, 2013. *WinWinD has submitted a voluntary petition on bankruptcy*. [Online]
Available at: <http://www.winwind.com/media-newlist.aspx?idvalue=211>
[Accessed 22 04 2014].

World Nuclear Association, 2014. *Nuclear Power in Finland*. [Online]
Available at: <http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Finland/>
[Accessed 03 02 2014].

yle, 2014a. *Katainen slutar som partiordförande*. [Online]
Available at: <http://svenska.yle.fi/artikel/2014/04/05/katainen-slutar-som-partiordforande>
[Accessed 07 04 2014].

yle, 2014b. *Urpilainen fick förklara sig på SDP-möte*. [Online]
Available at: <http://svenska.yle.fi/artikel/2014/03/29/urpilainen-fick-forklara-sig-pa-sdp-mote>
[Accessed 07 04 2014].

yle, 2014c. *Rinne beredd att bli minister - men?*. [Online]
Available at: <http://svenska.yle.fi/artikel/2014/04/07/rinne-beredd-att-bli-minister-men>
[Accessed 07 04 2014].

yle, 2014d. *Niinistö: Grundlagen kräver inte nyval*. [Online]
Available at: <http://svenska.yle.fi/artikel/2014/04/07/niinisto-grundlagen-kraver-inte-nyval>
[Accessed 07 04 2014].

yle, 2014e. *Rinne blir finansminister*. [Online]
Available at: <http://svenska.yle.fi/artikel/2014/05/28/rinne-blir-finansminister>
[Accessed 02 06 2014].

Yli-Teevahainen, V., 2013. *PROGRAM FÖR MILJÖKONSEKVENSBEDÖMNING AV VINDKRAFTSPROJEKTET I HEDET-BJÖRKLIDEN*. [Online]
Available at: http://www.miljo.fi/sv-fi/Arendehantering_och_tillstand/Miljokonsekvensbedomning/MKBprojekt?n5=2
[Accessed 20 04 2014].

Yuhas, A., 2014. *Ukraine crisis: an essential guide to everything that's happened so far*. [Online]
Available at: <http://www.theguardian.com/world/2014/apr/11/ukraine-russia-crimea-sanctions-us-eu-guide-explainer>
[Accessed 20 04 2014].

Interviews

Hillforth, C., 2014. *Project director VindIn AB* [Interview] (26 05 2014).

Kuusela, A., 2014. *Adviser Power Plants, Fingrid Abp* [Interview] (19 03 2014).

Liukko, A., 2014a. *Counsellor, The Energy Department of the Ministry of Employment and the Economy* [Interview] (19 03 2014).

Lundberg, J., 2014. *Executive Chairman and Founder* [Interview] (05 05 2014).

Paalatie, H., 2014. *Operational manager, Finnish windpower association* [Interview] (18 03 2014).

Stormoen, P., 2014. *Managing Director, O2 Vindkompaniet* [Interview] (06 05 2014).

Ståhlberg, J., 2014. *Procurement Manager Vattenfall Vindkraft AB* [Interview] (23 04 2014).

Tenhovirta, M., 2014. *Technical Adviser, The Energy Authority* [Interview] (19 03 2014).

Seminars

Becker, T. C. e. o. E., 2014. *Wind in power – Wind energy in the European power mix*. Vaasa: s.n.

Liukko, A., 2014b. *Selection for an off-shore wind farm demonstration project underway and other current topics concerning the promotion of wind power*. Vaasa, The Ministry of Employment and the Economy.

Niinistö, V. M. o. t. e., 2014. *Conclusions*. Vaasa: s.n.

Pöyry, 2014. *Pöyry*. Stockholm: Pöyry.

Suominen, J. C. o. t. b. a. t. F. w. p. o., 2014. *Finland on its way to 2500 MW*. Vaasa: Finnish Wind Power Organisation.

Movies

Lundberg, J., 2011. *Praktiska erfarenheter*. s.l.:The Edulab YouTube.

Appendix 1: Developer survey

The survey was sent out to 52 companies within the industry and 12 answers were received back:

- 8 developers
- 3 consultancies
- 1 financial investor

The survey was online-based and given in English (1 answer), Finnish (9 answers), Swedish (2 answers). The translation to Finnish was administered by a professional translation company. The English version is presented below:

Dear respondent,

We are two industrial engineering and management students at Lund University in Sweden writing our master thesis. Our thesis is about wind power in Finland, we are mapping the market to identify the strongest drivers and make a prognosis for the business conditions within the industry.

We would very much appreciate if we could have 5 minutes of your time for answering our survey (10 questions) about wind power in Finland. Please note that the thesis is a public document in Sweden. All answers will be handled anonymously.

1. How much wind power has your company built in Finland until the present day?
 - a. Number of wind turbine generators?
 - b. Installed effect in MW?
2. How much wind power does your company own in Finland today?
 - a. Number of wind turbine generators?
 - b. Installed effect in MW?
3. The Finnish government has a goal of 6 TWh wind power by 2020, what is your perspective of future expansion. How much wind power is your company expecting to have built by 2020?
 - a. Number of wind turbine generators?
 - b. Installed effect in MW?
4. What would you define your company as?
 - a. Wind developer

- b. Consultant
 - c. Financial Investor
5. Several external threats exists for wind operations, select the 3 that affects you the most.
 - a. The Crimea crisis
 - b. The domestic political turbulence with the leaving prime minister
 - c. The low Finnish growth and high unemployment
 - d. Unclear directives from the EU about the climate goals for 2030
 - e. Retroactive repayment of the feed-in tariff (which happened in Spain due to governmental deficits)
 - f. The Finnish tariff-system fills up and will not be followed by a new one, causing sunk cost for those projects not included
 6. Which are the biggest obstacles/bottlenecks for building wind power in Finland today?
 7. Wind power requires large investments, please tick the financing options that your company use
 - a. Bank loan
 - b. JV with smaller developers
 - c. JV with large utilities
 - d. JV with financial investors
 - e. Wind cooperatives for private investors and companies
 - f. We do not need external financing
 8. Do you use Finnish or international investors?
 9. Do you consider it hard to find investors for wind power in Finland today?
 10. Icing is a problem in the north
 - a. How have you handled icing?
 - b. What is the production loss per turbine due to icing?

Main finding from the survey

1. A majority of the participants found it easy to attract capital for wind power investments in Finland, more so for larger projects and projects in high wind locations.

2. The most common forms of financing used were; bank loans followed by joint ventures with a financial actor and joint ventures with a utility.
3. Both Finnish and international capital is used.
4. The following risks, written in the order of importance, were considered the greatest;
 - a. Unclear directives from EU about the climate goals for 2030.
 - b. The Finnish tariff-system fills up and will not be followed by a new one, causing sunk cost for those projects not included.
 - c. Retroactive repayment of the feed-in tariff (which happened in Spain due to governmental deficits).

Appendix 2: Interview questionnaire

The interviews were conducted with;

- Anja Liukko, Counsellor at The Energy Department of the Ministry of Employment and the Economy
- Heidi Paalatie, Operational Manager at the Finnish Wind Power Association
- Mari Tenhovirta, Technical advisor at the Energy Authority
- Antti Kuusela, Advisor at Fingrid.

The interviews were conducted during the Vaasa Wind Exchange conference March 18-19, 2014.

1. What are the main tasks in your work?
2. In what ways do you come in contact with the wind industry in your work?

Finland overall

1. What is the general public attitude towards wind power in Finland?
 - a. Are there any areas that are more positive vs negative?
 - b. Have any surveys in this area been done?
2. "But not in my backyard" is a common expression concerning the attitude towards wind power in Sweden, does that apply well in Finland too?
 - a. How can one change and prevent this attitude?
3. New nuclear reactors are and will be constructed, how do you expect this to affect the electricity price?
4. What are the long-term prognoses of the electricity price in Finland?
5. Has and does the situation in Crimea affect the electricity price?
6. Have the Finnish GDP decrease in recent years affected the wind power development?
7. Who are most powerful on the electricity market, the producers or the industrial buyers?
8. Do you see an increase in backward integration within electricity intense industries by i.e. building their own wind turbines?
9. Which are the biggest technological challenges for wind power development in Finland?

- a. Icing? The grid?

Subsidies

10. At what time in the process does the developer know for sure that they will receive the subsidy?
11. A plant can receive the feed-in tariff for 12 years or up to a certain level, how is that level decided?
12. The current tariff system is in effect until the installation target of 2500 MW nominal effect is reached.
 - a. How do you define nominal effect?
 - b. When do you estimate the capacity will be reached?
 - c. Will there be a “race” between developers in the end?
 - d. What are the incentives for developers to keep constructing wind farms when 2500 MW is reached?
 - i. New subsidies or do you think wind power will carry itself by then?
 - ii. What are the market expectations?
13. Is the 9 TWh (3750 MW) goal by 2025 official? Since when?
 - a. Will/Do this in any way affect the current tariff system?
14. Is there a risk that the tariff system will be changed or decrease due to unfavourable economic conditions for the government?

The grid

15. Do wind power and other renewables have grid priority?
16. Is Fingrid's investing enough in the grid to handle the expansion of wind power?
 - a. What are the directives from the owners?
17. Are the transnational grid connections enough or are there new connections in the project pipeline?
18. As of today, are there any particular bottlenecks in the grid?
 - a. Any plans to introduce electricity areas like the other Nordic countries?
 - i. Why/Why not?
19. How will the grid handle when the planned nuclear reactors start commercial operations?
20. How do the fees flow? Who do the developers pay to and who do the grid owners pay to?
 - a. How does Fingrid regulate these prices?

- b. How much of the infrastructure investments are charged to the developers?

The permit process

21. Can one build on land that has not been planned or does not have decision on exception?
22. Can the decision on exception from planning only be made for a solitary wind turbine or also for several wind turbines?
23. What happens if the area is planned for other purposes?
24. Into what phase would you divide the process of building a wind park?
25. How long do the phases take on average?
26. The ELY's give the final statements on the EIA. Where are they publicised?
27. When the EIA is approved is the next step applying for construction permits?
28. When and which permit is irrevocable?
29. Where are the irrevocable permits found? Are they found per municipality or at a common website?
30. Is there a municipality veto in Finland?
31. Is there a plan or goal to speed up the processes involved in wind development?
32. How are you, and your organization, involved in the permit process?
33. Are there any particular bottlenecks in the permit process?
 - a. How can they be solved?
34. Is there a property tax for wind turbines?
 - a. How much?
 - b. Federal or municipal?

Icing

35. In what regions does icing pose a problem?
36. Are there any acceptable solutions on the market?

Non-categorized

37. Are there more compensation areas for wind power currently being investigated?
38. What is your take on offshore?
 - a. Viable?
 - b. Particular goals?
 - c. Subsidies?
39. Are there any particular centres for wind power research in Finland?

- a. Where?
- b. Focus on research?

Final questions

- Do you have statistics of the costs of development/ operation of wind power in Finland?
 - Property taxes, grid tariffs, transportation costs for turbines, land leases etc?
- How do you foresee the future of wind power in Finland?

Appendix 3: Excerpts from financial evaluation

Project1; Greenfield project. Assumptions from section 6.1. IRR = 5.6 %, NPV = - 5.3 MEUR

		CC (non inflation)	CC (inflation)	CC adjusted for inflation	CB	CF	CF after tax	Inflation	Spot price	Land lease	Property tax	ack NPV
1	m=1		0,09	0,09				1,4%				-0,085
2	m=2		1,22	1,26				1,4%				-1,162
3	m=2		0,48	0,50				1,6%				-1,558
4	m=2		0,42	0,45				1,8%				-1,887
5	m=3		0,50	0,55				1,8%				-2,259
6	m=4		48,10	53,85				1,9%				-36,194
7	m=6	0,6428	0,97	1,11	8,08	6,33	6,33	1,9%		0,3233	0,32	-32,501
8	2021	0,6349	0,97	1,13	8,08	6,32	6,32	1,9%		0,3233	0,31	-29,086
9	2022	0,6269	0,97	1,15	8,08	6,30	6,30	1,9%		0,3233	0,30	-25,935
10	2023	0,6189	0,97	1,18	8,08	6,29	6,17	1,9%		0,3233	0,30	-23,079
11	2024	0,6109	0,97	1,20	8,08	6,27	5,87	1,9%		0,3233	0,29	-20,561
12	2025	0,6029	0,97	1,22	8,08	6,26	5,65	1,9%		0,3233	0,28	-18,319
13	2026	0,5949	0,97	1,24	8,08	6,24	5,47	1,9%		0,3233	0,27	-16,306
14	2027	0,5869	0,97	1,27	8,08	6,23	5,34	1,9%		0,3233	0,26	-14,487
15	2028	0,5789	0,97	1,29	8,08	6,21	5,24	1,9%		0,3233	0,26	-12,835
16	2029	0,5709	0,97	1,32	8,08	6,20	5,16	1,9%		0,3233	0,25	-11,330
17	2030	0,5630	0,97	1,34	8,08	6,18	5,09	1,9%		0,3233	0,24	-9,953
18	2031	0,5550	0,97	1,37	8,08	6,16	5,04	1,9%		0,3233	0,23	-8,691
19	2032	0,4079	0,97	1,39	4,61	2,80	2,33	1,9%	0,000048	0,1842	0,22	-8,152
20	2033	0,4017	0,97	1,42	4,65	2,83	2,33	1,9%	0,000048	0,1860	0,22	-7,652
21	2034	0,3956	0,97	1,45	4,70	2,86	2,33	1,9%	0,000049	0,1879	0,21	-7,189
22	2035	0,3894	0,97	1,47	4,74	2,88	2,34	1,9%	0,000049	0,1897	0,20	-6,758
23	2036	0,3833	0,97	1,50	4,79	2,90	2,35	1,9%	0,000049	0,1916	0,19	-6,358
24	2037	0,3771	0,97	1,53	4,84	2,93	2,36	1,9%	0,000050	0,1934	0,18	-5,985
25	2038	0,3710	0,97	1,56	4,88	2,95	2,38	1,9%	0,000050	0,1953	0,18	-5,639
26	2039	0,3649	0,97	1,59	4,93	2,97	2,39	1,9%	0,000051	0,1971	0,17	-5,315

CC = cash flow of costs, CB = cash flow of benefits, CF = cash flow

Project2; Brownfield project. Assumptions from section 6.1. IRR = 7.1 %, NPV = - 2.5 MEUR

		CC (non inflation)	CC (inflation)	CC adjusted for inflation	CB	CF	CF after tax	Inflation	Spot price	Land lease	Property tax	ack NPV
1	m=4		51,70	52,68				1,4%				-48,541
2	m=6	0,6127	0,97	1,01	8,08	6,46	6,46	1,4%		0,3233	0,29	-43,003
3	2016	0,6055	0,97	1,03	8,08	6,45	6,45	1,6%		0,3233	0,28	-37,886
4	2017	0,5982	0,97	1,05	8,08	6,43	6,43	1,8%		0,3233	0,27	-33,157
5	2018	0,5910	0,97	1,07	8,08	6,42	6,25	1,8%		0,3233	0,27	-28,904
6	2019	0,5838	0,97	1,09	8,08	6,41	5,96	1,9%		0,3233	0,26	-25,148
7	2020	0,5765	0,97	1,11	8,08	6,39	5,74	1,9%		0,3233	0,25	-21,798
8	2021	0,5693	0,97	1,13	8,08	6,38	5,57	1,9%		0,3233	0,25	-18,787
9	2022	0,5621	0,97	1,15	8,08	6,37	5,44	1,9%		0,3233	0,24	-16,063
10	2023	0,5548	0,97	1,18	8,08	6,35	5,35	1,9%		0,3233	0,23	-13,587
11	2024	0,5476	0,97	1,20	8,08	6,34	5,27	1,9%		0,3233	0,22	-11,328
12	2025	0,5404	0,97	1,22	8,08	6,32	5,21	1,9%		0,3233	0,22	-9,261
13	2026	0,5331	0,97	1,24	8,08	6,31	5,16	1,9%		0,3233	0,21	-7,365
14	2027	0,3776	0,97	1,27	4,37	2,73	2,27	1,9%	0,000045	0,1750	0,20	-6,594
15	2028	0,3722	0,97	1,29	4,42	2,76	2,27	1,9%	0,000046	0,1768	0,20	-5,879
16	2029	0,3668	0,97	1,32	4,47	2,78	2,27	1,9%	0,000046	0,1787	0,19	-5,215
17	2030	0,3614	0,97	1,34	4,51	2,81	2,28	1,9%	0,000047	0,1805	0,18	-4,598
18	2031	0,3560	0,97	1,37	4,56	2,84	2,30	1,9%	0,000047	0,1824	0,17	-4,023
19	2032	0,3506	0,97	1,39	4,61	2,86	2,31	1,9%	0,000048	0,1842	0,17	-3,488
20	2033	0,3452	0,97	1,42	4,65	2,89	2,32	1,9%	0,000048	0,1860	0,16	-2,990
21	2034	0,3398	0,97	1,45	4,70	2,91	2,34	1,9%	0,000049	0,1879	0,15	-2,525