Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Economics and Management
Dept. of Industrial Economics and Technology Management

Merethe Tvedt

Bilateral vs. Financial Contracting in the Nordic Electricity Market

Master's thesis in Industrial Economics and Technology Management
Supervisor: Stein-Erik Fleten
Co-supervisor: Ståle Størdal

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Problem Statement

This Master's thesis has its starting point in the observation of a recent and significant increase of signed PPAs in the Nordic power market, while liquidity of Nordic power futures on the other hand has been declining over the past decade. The thesis aims to identify and evaluate Norwegian power producer's role in the recent developments, by investigating their motivation and practices of bilateral and financial contracting.

The research questions this thesis will answer are:
1) Has the use of PPAs changed among Norwegian power producers?
2) Are PPAs more favorable hedging instruments than Nordic power futures?
3) What are possible effects of PPA use on the financial derivatives market?

Preface

This Master's thesis is written at the Norwegian University of Science and Technology (NTNU) at the Department of Industrial Economics and Technology Management, during the spring semester of 2021.

I would like to acknowledge and thank my supervisor, Professor Stein-Erik Fleten, and my co-supervisor, Professor Ståle Størdal (at the Inland Norway University of Applied Sciences (INN)), for their exemplary guidance throughout the semester. Their continuously constructive feedback and our interesting discussions have been of great value to my work. I would also like to express my gratitude towards the participating companies from industry for their time and engagement in my work. Their insights have been of high academic and practical interest, making this thesis possible.

Trondheim, 11th June 2021

Merethe Tvedt

Abstract

There has recently been a trend of increased use of Power Purchase Agreements (PPAs) in the Nordic power market. Simultaneously, liquidity in the financial market (Nordic power futures at Nasdaq Commodities) has been decreasing to a critical level. This thesis investigates these recent developments by conducting empirical research on practices and market views of Norwegian power producers. 12 of the largest power companies in Norway participate. The findings suggest that power producers are motivated to partially transition from financial to bilateral contracting, due to the poor liquidity in the financial market. The study also finds a large gap between available prices and price expectations and a lack of trust in the exchange's ability to protect against credit risk. The thesis serves as a warning signal on the current status of the financial power market. Further, this thesis can provide policy makers and regulators in the market with decision support when evaluating the sufficiency of hedging opportunities, especially related to the expected introduction of the European Union's Forward Capacity Allocation (FCA) guidelines.

Sammendrag

I løpet av de siste årene har det vært en betydelig økning i bruk av PPA (Power Purchase Agreement) i det nordiske kraftmarkedet. Samtidig har likviditeten i det finansielle markedet (kraftderivater handlet på Nasdaq Commoditites) sunket kraftig, og ligger i dag på et kritisk nivå. Denne masteroppgaven undersøker den aktuelle utviklingen gjennom intervjuer med kraftprodusenter om deres praksis og markedssyn, og 12 av de største norske kraftselskapene deltar i studien. Studiens funn tyder på at kraftprodusenter har insentiver til å gå delvis bort fra bruk av finansielle derivater til sikringsformål, til fordel for økt PPA-bruk, spesielt på grunn av det finansielle markedets manglende likviditet. Studien avdekker også et stort gap mellom tilgjengelige priser og aktørenes prisforventninger, samt manglende tillit til børsens beskyttelse mot kredittrisiko. Oppgaven fungerer som et faresignal for statusen til det finansielle Nordiske kraftmarkedet. Videre kan denne oppgaven gi støtte til beslutningstakere og regulatorer i markedet når de vurderer om markedets finansielle sikringsmuligheter er tilstrekkelige. Dette er spesielt knyttet til den forventede innføringen av EUs FCA-retningslinjer (Forward Capacity Allocation guidelines) for terminmarkedet.

Contents

1 Introduction

Market participants have taken to their heels and largely disenrolled from the trade of Nordic power futures on the Nasdaq Commodities exchange (hereafter 'Nasdaq'). The liquidity of available financial power derivatives has since the financial crisis been declining, and might today be at a critical level. The use of Power Purchase Agreements (PPAs) has over the same time period trended strongly in the opposite direction (Copenhagen Economics, 2020). A Power Purchase Agreement (PPA) is a bilateral contract for the trade of power between a producer and a buyer. The term will in this thesis be used as a term for all contracts that fall into this category, leaving aside the discussion of other possible interpretations. Despite the clear need for a better understanding of the influence of PPAs on the functionality of power markets, there exists a limited amount of academic research addressing the topic.

PPAs are often sold from production by a relatively new producer type; specific wind generation projects (THEMA, 2021). These new producers have very different hedging needs compared to traditional power producers. While project developers are facing large upfront installation costs, power companies operating existing hydropower plants have largely repaid their debts from installation of their plants. For the project owner, financial hedging is not an option as they are likely not capable of complying with the margin requirements of clearing houses. Nor are they likely to get loans to fund projects without providing more long-term protection against price risk than the financial derivatives market can offer.

Like wind projects have been arising as a new type of producers, battery factories and data centres are emerging as new types of consumers. These industries are also seen tied to PPAs as they are highly electricity intensive (Copenhagen Economics, 2020). What kind of risk management do these new market participants need? A PPA serves as a long-term hedging tool that ensures wind project developers required risk mitigation for loans, and provides electricity intensive consumers with predictable power prices. PPAs also cater an evolving need for Guarantee of Origin (GO) certificates of renewable energy. To meet greenhouse gas reduction targets, electricity that is demonstrable from renewable energy sources is sought after. This increased demand has also has been seen in Norway, and *Energi Norge* introduced a Norwegian industry standard for GOs in 2021[1].

Looking forward, electrification of national infrastructure will only increase the need of long-term hedging opportunities. Hydrogen production is another highly electricity intensive and growing industry. For production to be profitable, producers of hydrogen must be able to rely upon predictable power prices. Further, if off-shore wind projects are to be realized, they require massive investment costs, in even larger scales than the installation costs seen for on-shore

[1] See: https://www.energinorge.no/nyheter/2021/ny-bransjenorm-for-opprinnelsesmerket-strom/

wind. Such an investment is hard to picture possible without the security of an associated PPA.

PPAs have over the last decade received attention in the media for being priced 'too high'. In some cases these PPAs have been accused to destroy functionality of the market, like by the article "Statkraft-agreements destroy market competition" (from *Dagens Næringsliv* on December 20th 2011, cited by Tungland (2012)). What is, however, the market price of power? The prices available in the financial Nordic power market are largely the base for the comparison in these cases. But are PPAs really priced 'too high' by power producers if you take into account the costs and margin requirements tied to financial contracts and add the value other PPA benefits for a power consumer? The price levels are in fact not as directly comparable as the media has showcased, and comparing futures prices and PPA prices might actually be "like comparing apples and pears", as put by a participant of this study.

This thesis takes a more narrow approach in this broad picture, and will explore important aspects of bilateral and financial contracting found in hedging practices of Norwegian power producers. Hedging practices have been of large importance for traditional Norwegian hydro-electricity companies since the market deregulation at the very beginning of 1991, and historically, the companies have mainly been hedging by the use of power futures on Nasdaq (previously these were in the form of forward contracts (Nasdaq Commodities, 2021)). This study will map power producers' role in the recent developments. While available research mostly focuses on PPAs tied to the installation of new capacity, this study will explore how traditional power producers, with generation from existing power plants, are using PPAs for hedging purposes. The study will also investigate possible outcomes of the current market situation. 12 of the largest Norwegian power producers are participating in the study, in total making up the majority of electricity production in the country.

Forward Capacity Allocation (FCA) guidelines

The impact of PPA use on financial markets is little studied. The European Union introduced the Forward Capacity Allocation (FCA) in 2016, which addresses the operation of forward markets, serving market participants mitigating long-term risks. The guidelines state that forward markets should provide adequate hedging opportunities for the market participants between different price areas (European Union, 2016). The FCA regulations do not apply in Norway at this point in time, but are according to the Norwegian Energy Regulatory Authority (NVE) expected to be introduced in near future (NVE, 2021). By the evaluation criteria developed by the FCA, if hedging opportunities turn out not to be adequate, measures like trade of long-term transmission rights must be implemented, to provide the traders with an insurance. In a recent report conducted by THEMA (2021), 24 of 44 of their respondents stated that they had insufficient opportunities to hedge their power price risk. The status of the financial market, with the perspective of the expected introduction of FCA guidelines, will therefore be discussed in this thesis.

A price perceived as fair in the futures market is largely associated with good liquidity in this market Copenhagen Economics (2020). Good liquidity is important to ensure efficiency and the sufficient hedging opportunities. Low liquidity can widen the bid-ask spread, resulting in higher costs for participants in the market. This seems to be the case for the futures available at Nasdaq, where the trading volume of power futures has declined from around 2500 TWh in 2008 to around 1000 TWh in 2019 (Nasdaq, 2021).

Aims, objectives and research questions of the study

Despite being an important tool for long-term hedging, the Nordic PPA market has at this point not been analysed in relation to the FCA requirements (Copenhagen Economics, 2020). As the PPA market is becoming of significant size, it seems relevant to include the effect of these contracts in an analysis of power price hedging. Sanda, Olsen, and Fleten (2013) studied practices of Norwegian electricity companies, finding that the application of market views in hedging decisions was a widespread practice. As a more speculative trading approach seems to be mixed with hedging practice in the industry, this perspective is also chosen to further investigate. In the light of previous research and the current market situation, an important gap in literature is found on the use of PPAs for hedging practices, and their effect on the financial power derivatives market.

This study will aim to investigate the role of power producers in recent developments in financial and bilateral contracting in the Nordic power market. This will be done by identifying to what extent Norwegian power producers use PPAs for hedging purposes. Further, the study will aim to uncover and evaluate motivation for transitioning from the use of financial derivatives to the use of PPAs. An objective of the study is therefore to map the motivational factors for use of PPAs for hedging practices by Norwegian power producers, and thereunder identify their distinction (or lack of distinction) between hedging and speculative trading. Another objective is to compare and contrast PPAs and the financial futures available in the Nordic power market, in terms of their benefits and shortcomings. Being closely related, the study also aims to assess implications of PPA use in regard to the status of the financial power derivatives market. Academic literature and financial theory will be used together with conducted interviews to answer the research questions that are devised from these aims and objectives.

The research questions of this study are:
1) Has the use of PPAs changed among Norwegian power producers?
2) Are PPAs more favorable hedging instruments than Nordic power futures?
3) What are possible effects of PPA use on the financial derivatives market?

Research question 1) is concerned with the seen changes in PPA use. Published reports argue that the change primarily is connected to establishment of new capacity (see chapter 2), so this study will investigate to what extent Norwegian

power producers are signing PPAs on existing production. The subsequent research questions are aimed to map two especially important aspects of financial and bilateral hedging; the contractual differences and whether they currently are designed to coexist in the market.

The scope of this study is limited to the Norwegian power market, with somewhat of a generalizability to the Nordic power market as these are linked tightly. Further, the study will be conducted on power producers. The study is therefore limited to companies that are mostly making up the seller side of PPAs and mostly take short positions in the financial futures market.

Possible contributions and research limitations

This study will contribute to the body of knowledge on hedging practices of Norwegian power producers, especially with regards to the current status of PPA use in the market. This will be done by surveying and evaluating the use of financial derivatives and PPAs for risk management in the power industry. The study will therefore help address the current scarcity of research in this area. It will also provide real-world value to regulatory authorities and companies operating in the power market, as plausible outcomes of the current market situation are discussed.

Some limitations should be noted. The scope of this study is as stated quite narrow, only including Norwegian participants. Practices regarding the use of power futures and PPAs of consumers and market participants in other Nordic countries are important for overall market interaction, and leaving them out will make it difficult to assess the complete situation. Time was an important resource limitation and hence a reason for the narrow scope. Further, the conducted study is empirical, based on interviews as a research tool. With this chosen methodology, it is important to keep in mind that participants of conducted interviews not always will give the correct answers, for whatever reasons. The choice to conduct interviews is however done with the intention of including 'human factors', making it possible to identify attitudes and motivations in addition to numerical values on their hedging practices. The answers of participants from Norwegian power producers are not necessarily coinciding with views of other Nordic actors. The results are however seen in light of, and compared with, reports and research on PPA use to strengthen their credibility. When generalizing the results of this study to the Nordic power market, these limitations should be kept in mind.

Structure of the thesis

The research objectives and questions have in this chapter been identified, and the rest of the thesis is structured as follows. In chapter two, the background on Power Purchase Agreements is presented. Chapter three consists of a literature review on topics related to success factors in derivatives markets, hedging and PPA use. Chapter four will explain the chosen methodology of the study. The results of the conducted interviews are presented in chapter five. A discussion of the results follows in chapter six, while the conclusion with policy implications are found in chapter seven.

2 Background: Power Purchase Agreements

Though long-term bilateral agreements have been present in the Nordic power market for decades, their use has, as presented in the introduction, seen a significant increase over the recent years. In this chapter, the background of PPA use is presented, with a historical perspective (2.1) as well as a more in-depth presentation of the recent developments (2.2).

2.1 A Historical Perspective

Before the deregulation of the power market at the very beginning of 1991 (see "Deregulation of Electricity Markets – the Norwegian Experience" by Bye and Hope (2005)), industrial power purchase was mainly conducted through bilateral agreements, and the price that state utilities offered was often used as a reference price (NVE, 2017). There had been a massive expansion of the Norwegian systems after the Second World War, with large-scale development of hydropower plants across the country as well as energy intensive industry. The government took an active role as a power producer during this period. Their motivation was to provide industry with cheap and reliable power, and the power was mostly sold to the industry through bilateral agreements (NVE, 2017).

The first power sold abroad was also by the use of bilateral agreements, and these agreements were based mainly on export of Norwegian power. A connection to Sweden in 1960 was the first abroad connection, partly financed by a Swedish loan repaid with Norwegian electricity. The first power connections with Denmark are further examples of abroad trade of bilateral kind, through the first submarine power cables from Norway set in operation in 1976 and 1977. (SNL, 2021)

After the deregulation, the Norwegian power market transitioned towards an ordinary market functionality, with multilateral trade. In 1994, financial trade of weekly contracts became possible through 'Statnett Marked', a platform later replaced by Nord Pool in 1996, together with the Swedish power market. Financial trade of power derivatives is today mainly conducted through the marketplace Nasdaq Commodities, who in 2008 acquired the Nord Pool trading place (Nasdaq Commodities, 2021). As a result of the deregulation of the market, use of bilateral and financial trade respectively declined and increased in many years entering the 2000's (Bye & Hope, 2005). The government still had large interest in bringing power producers and electricity intensive industry together. The Norwegian Export Credit Guarantee Agency (GIEK) did in 2009 introduce a power purchase guarantee, issued to power producers to protects against a buyer's non-fulfilment of a contract (GIEK, 2021). The use of this scheme did not become widespread as it was considered quite costly. In 2017, the first instance of use was made by the wind power sites Raudfjell and Kvitfjell (project

'Nordlicht') on the seller side[2]. If facing a default by the offtaker, the guarantee would ensure the power producer to receive the contractual price.

2.2 Recent Developments

The market did not reach a steady-state. The introduced increase in PPA use can be seen in Norway, as well as the rest of Europe, as shown in figure 1. The increase, largely due to new buyers and sellers that have entered the market, have been based on growth in the wind and solar power industries (Oxford Energy, 2021). Both practical and financial features of the PPA differentiate them from other derivatives used for hedging price risk, making them more favorable in some situations.

The seller side of the PPAs mainly consists of traditional power producers and new renewable energy developers of wind and solar power. The offtakers are electricity intensive industry (like aluminium, steel and ferrosilicon) and other consumers with a high electricity consumption (like some retail companies). Data centres have to an increasing degree become buyers of the contracts. (Copenhagen Economics, 2020)

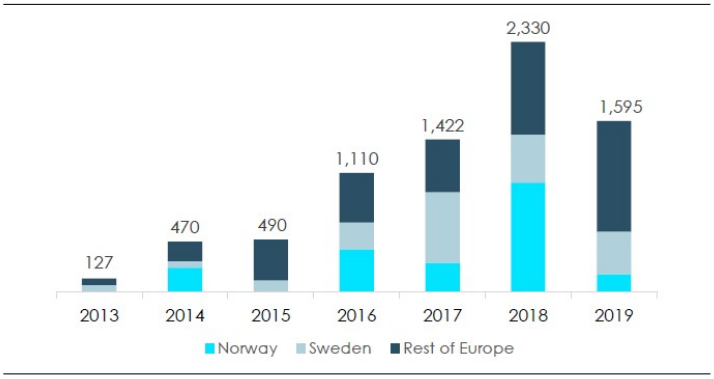

Figure 1: Signed PPAs in Norway and in Europe [MW] (note: the list is not complete). (Copenhagen Economics, 2020)

Over the recent years, some reports on PPA use and development have been published. Energy Brainpool (2018) investigates benefits and disadvantages of financing renewable energy projects, especially wind farms, using PPAs. In 2020, the Norwegian Energy Regulatory Authority (NVE) commissioned a report from Copenhagen Economics on the development in PPA use, as it wishes to understand current trends and developments in the Norwegian power market to help the task of forming their regulations. The most recent reports found

[2]https://www.giek.no/presse-og-nyheter/nyheter/vindkraftprosjektene-kvitfjell-og-raudfjell-inngar-langsiktig-kraftavtale-med-garanti-fra-giek

by the author of this thesis are conducted by The Oxford Institute for Energy Studies (2021) and THEMA (2021). They are studying PPAs' effects on the growth of renewable energy, and implications for the electricity markets and the FCA guidelines presented in chapter 1 of this thesis, respectively.

PPAs' distinctive attributes have contributed to their increased popularity. The agreements are tailored to the needs of the buyer and seller, allowing for price characteristics, volume profile and additional values to be as desired by the companies. This clearly has potential of covering needs that standardized financial contracts cannot. Further, regulations in the market seem to favour physical PPAs to some extent. Financial regulations, like MIFID II 26 (the obligation to report transaction) and IFRS (accounting standards) are only adding costs for financial products (which includes financial PPAs) (Copenhagen Economics, 2020). There are today few regulatory barriers to PPAs on physical delivery in Norway. More on tax and regulations is found in chapter 5.

While there are some clear advantages of PPAs, the agreements will also have an additional cost of negotiation. Finding counterparts and negotiating the contractual elements are the cost of the flexibility the agreements bring. Another disadvantage of PPA use is counterparty risk. This can be a potentially large cost of a PPA, and must therefore be considered carefully. In comparison, regulations in financial markets significantly reduce counterparty risk. (Copenhagen Economics, 2020)

Figure 2: Trading volume of Nordic power futures at Nasdaq Commodities [TWh] (Copenhagen Economics, 2020).

Interaction between PPAs and the financial market

The financial evaluation of PPA price is today possible on the basis of available futures market prices in the short-term and medium-term at Nasdaq, and fundamental power price modeling in the medium- to long-term (Energy Brainpool, 2018). This value will in theory be the fair distribution of business opportunities and risks between the parties of the agreement.

Though the reviewed reports state that PPAs and financial power derivatives mainly cater different needs, Copenhagen Economics (2020) address the decline of the trading volumes of the Nordic power futures at Nasdaq. The development, beginning in 2008, can be seen in figure 2. Though Copenhagen Economics (2020) state that "despite the correlation, the increase in the corporate PPA market is mainly new capacity which was not already in the market", this study will investigate the details of correlation further. On one side, the introduced main drivers of PPA use are factors like wind power and data centres, that do not have financial derivatives as an alternative for hedging. Hence, the increased volume of signed PPAs might not have an impact on the financial market. On the other side, if traditional power producers and established consumption have incentives to transition, partly or fully, from financial to bilateral hedging, it might be possible to identify not only correlation, but also causality.

3 Literature Review

This chapter aims to map the research applicable to the recent developments seen in the financial Nordic power market, as well as the development in PPA use. This literature is relevant to a power producer, or more generally a commodity producer, managing electricity price risk in the current situation of the Nordic market.

Section 3.1 presents literature on factors determining success in derivatives markets. Literature on the financial theories on hedging is presented in 3.2, focusing on the development of this discipline. Section 3.3 presents studies conducted on the hedging practices of Norwegian electricity companies, and literature on the use of long-term contracts in electricity markets is presented in section 3.4.

3.1 What Determines Success in Derivatives Markets?

Futures contracts have been one of multiple financial innovations arising over the last decades. Silber (1981) studied the development of futures contracts and also developed a framework for understanding how financial innovations have gained a foothold, where he emphasizes that financial innovation provides real benefit for the economy (Silber, 1983). He also found a definite advantage for the exchange that lists a futures contract first, so-called 'first-mover advantage'. This speaks for limited incentive for market participants to trade a new contract, when an existing, liquid contract is available. Black (1986) defined successful derivatives contracts as those who maintain consistently high trading volumes and open interest. He also wrote that the size of cash market, risk-reduction ability of the derivative contract, price variability of the underlying asset, and liquidity costs influence these success characteristics.

What makes some futures or other financial derivatives to be successful, and others fail? M. H. Miller (1986) argued that taxes and regulations were catalysts for financial innovation, when he reviewed the developments of the preceding 20-year period. He also predicted the innovation to slow down in the years following his published article, as society at that point had recovered from periods of depression and war. Timmons, Dingee, and Smollen (1990) later also investigated the rapid development of financial innovations, stating more broadly that "opportunities are spawned when there are changing circumstances, chaos, confusion, inconsistencies, lags or leads, knowledge and information gaps, and a variety of other vacuums in an industry or market".

Futures exchanges seem to have had difficulties with predicting the success or failure of futures contracts, as Carlton (1984) wrote that most new futures contracts fail within 10 years of their introduction. Tufano (2003) surveyed literature on financial innovations and pointed out the limited amount of literature on the topic of what makes them successful. Some research that has been done is by Brorsen and Fofana (2001), who studied the successes and failures of agricultural futures contracts by estimating the effects of several factors,

finding that an active cash market (spot market) perfectly predicted whether or not a commodity had a futures market. Changes in market structures for some commodities could however cause the contracts to fail, and for those commodities with a cash market active enough to support a futures market, other factors such as cash market size, liquidity cost, market structure, and grading system effectiveness help determine volume and open interest. Holland and Vila (1997) investigated successful futures contracts at LIFFE (London International Financial Futures Exchange), finding that cash market size and volatility are highly correlated with the level of turnover in the associated futures market. They also found a first-mover advantage in the case of competitive contracts. Tashjian (1995) studied optimal futures contract design. Describing how a new futures contract can be predicted as successful, she wrote that it "most likely will be a contract with strong appeal to a large group of investors who bear substantial price risk which is costly to diversify".

A small selection of more recent literature on the topic was also found. Hung, Bing-Huei, Huang, and Chou (2011) examined factors that influenced the success of exchange traded futures contracts in Asian markets. The results showed that futures benefit from a large and volatile cash market, later backed by Waweru and Kim (2015). Also, a smaller contract size had a positive effect on trading volume, and the relative size of exchanges influenced the success of the futures contracts in their empirical results. Their results did not support theory on first-mover advantage, meaning that simply being the first did not guarantee success in futures listing on the exchange. Waweru and Kim (2015), who were also studying Asian derivatives markets, found that options were relatively more successful (which they defined in terms of trading volume) than futures contracts on the same underlying, which they argued could be due to the costs associated with margin requirements.

Webb (2018) tells the story of how real estate derivatives (commercial and residential property derivatives), were anticipated to be large successes, but have turned out to be unsuccessful, as there have been few market participants. Shiller (1995) expected them to be thriving financial products, but as they were not, he later investigated his own miscalculated prediction. He then found arguments to support lack of liquidity as a reason for the lack of interest for the financial product (Shiller, 2008). The author further argued that the lack of liquidity makes potential users reluctant to trust the prices generated in the market or use the contracts for hedging.

Webb (2018) lists some elements that can be found associated with financial products in successful derivative markets, and he points out the need to evaluate which commodities are suited as underlying assets for futures contracts by examining these elements. His list of success factors are:

1. Price volatility of the commodity
2. The need to hedge

3. Good contract design (rules governing trading, to prevent abuse)
4. Public order flow
5. First-mover advantage
6. Actively traded related futures (to facilitate spread trading)
7. Liquidity
8. Lower cost of trading
9. Attract the interest of speculators
10. Timing (important to list new contracts at the right time)

(Webb, 2018)

Price volatility (1) is largely considered to be correlated with a successful derivative. The quote by Webb (2018) "Volatility is the lifeblood of trading" speaks for itself when it comes to his perception of importance of this factor. Volatility is substantial in the electricity commodity market. Lucia and Schwartz (2002) found an an annualized volatility at the Nord Pool spot market of up to 189 %. The need to hedge (2) naturally follows from price volatility.

Theory on first-mover advantage (5) is mixed. Silber (1983) and Holland and Vila (1997) found evidence of first-mover advantage to be of significance in competitive markets, but this is not supported by everyone as Hung et al. (2011) found no support for the advantage of listing first. Timing (10) can be seen in connection with this theory, as the importance to list new contracts at the right time is connected to competitive aspects. It is however also very important to consider needs of the market participants to find the right timing.

Liquidity (7) is of concern especially when a market is lacking it. Therefore, "the market may prefer a *good* hedging vehicle to the *perfect* if the *good* hedging vehicle is more liquid" (Webb, 2018). Speculators are part of liquidity providers, and Webb (2018) explains (9) by writing "the public doesn't like to go short". This quote underlines the importance of speculators in the market to even out numbers of short and long positions, and these speculators will 'smooth' the available prices – making sure there are no arbitrage opportunities. By the term 'Public order flow', Webb means that there are active traders consisting of the 'uninformed public (what he calls 'bona fide' hedgers). Their interest is contributing to the increase of the market's liquidity.

Failure is common for products in all kinds of market, and there is no apparent reason why derivatives markets should be different. According to Porter (1980), the two primary factors that impact market favorability in any industry are structural entry barriers and the expected reaction of incumbent firms. He created generic strategies, for all (primarily non-financial) products, based on market analyses to maximize probability for a product's success. However, a

firms' analysis will not guarantee success, and success is often also transient. Webb (2018) therefore stresses that no factors can guarantee a derivatives' success.

Competition among market intermediaries
The intermediaries in the market mainly consists of exchanges, clearing houses and brokers settling OTC transactions. Pagano (1989) explored the scope of differentiation between two exchanges, where one was attracting more trades. The value the liquidity had for some traders made it possible for the exchange to charge higher fees in return. An interpretation of this, in addition to the importance of liquidity, is that heterogeneity in traders give an opportunity for differentiation among intermediates in the market. Market coexistence is then possible.

Holder, Tomas, and Webb (1999) examined competition among exchanges in their offerings of options and financial futures. They found that the most important factors of winning competition against other exchanges were: which exchange lists first, relative size of competing exchanges (larger exchanges being more successful), and whether the futures market is located in the same country as the principal cash market. Pennings and Leuthold (2001) examined the impact introduction of new futures contracts has on existing futures in the market, finding elements of importance for a futures exchange's innovation policy. The introduction of a new futures contract can possibly lead to cannibalism, which leads to a decrease in volume of already traded contracts, resulting in declined liquidity. Ultimately this could threaten the exchange's viability.

On power markets, Peña and Rodriguez (2016) conducted a study on the efficiency of efficiency of European power derivatives markets. Liquidity in the French and Spanish markets was reportedly limited, and the authors suggested improving liquidity by pricing and marketing incentives. They also considered the co-existence of OTC trades and exchange-traded futures. They recommended clearing houses to publish statistics on long and short positions associated to type of participant (power companies among others), pointing to similar publications by the U.S. Commodity Futures Trading Commission (CFTC). Encouragement of settling OTC trades in clearinghouses was also suggested as a means to increase liquidity.

3.2 Financial Theory on Hedging

Williams (1939) introduced the conservation of value principle, stating that capital structure and financial transactions affect the value of a firm only due to some type of market imperfection. The classical proposition by Modigliani and Modigliani and Miller (1958) substantiates this: Under the conditions of a perfect capital market, the value of a firm is independent of whether or not it hedges, as the total value of the firm's securities only is dependent on, and equal to, the market value of the total cash flows generated by its assets (Berk & DeMarzo, 2017).

More recent corporate finance research on imperfect markets suggests that

there are several ways hedging can add value to a firm. Smith and Stulz (1985) find that a value-maximizing firm will hedge for three reasons; 1) reduction of corporate taxes (through the reduction of the variability of pre-tax value of the firm), 2) reduction of default risk and 3) due to stakeholder risk aversion. Increasing the debt capacity can be an incentive for hedging, as this increases the potential benefit from tax deduction (Stulz, 1996). Risk management can make internal cash flows more available for a corporation's growth opportunities, reducing the cost of external financing or the opportunity costs of foregoing profitable investment projects (Froot, Scharfstein, & Stein, 1993), (Aretz, Bartram, & Dufey, 2007). Reducing costly divergent interests between shareholders and company managers (agency costs) is also mentioned as a way shareholder value can be increased through corporate hedging (Geyer-Klingeberg, Hang, Rathgeberg, Stöckl, & Walter, 2018), (Nance, Smith, & Smithson, 1993), (Aretz & Bartram, 2010), and hedging can add value if the derivatives contracts have risk premia that are inconsistent with the inherent risk (Jin & Jorion, 2006). The importance of financial risk management is also becoming increasingly apparent to firms whose primary operations is not of a financial nature (Oh, 2018).

Several studies have investigated the use of derivatives for hedging purposes with the general conclusion that large firms hedge more (Nance et al., 1993). Indications are also that firms with lower cash balances seem to hedge more (Tufano, 1996), (Haushalter, 2000). Gilje and Taillard (2017) found direct empirical evidence that financial distress and under-investment are main reasons for why firms hedge. Many empirical studies also obtain a significant result on dividend payments impacting hedging practices, but the relation is varying across studies (Aretz & Bartram, 2010).

Oh (2018) suggest that firms perform financial risk hedging for reasons other than just reducing price risk, such as e.g. supplementing capital-raising activities. This is supported by Aretz and Bartram (2010). These authors found that, with numerous empirical works intending to map out the determinants of corporate hedging, results of their hedging practices are conflicting and mixed. In addition to pointing to endogeneity problems (firm value might in fact determine corporate hedging to a greater degree than hedging determines corporate value), the authors question if this problem might stem from the fact that corporate risk management can be motivated by other factors than those covered by existing risk management theory.

Is hedging always beneficial?

"Is Corporate Hedging Always Beneficial? A Theoretical and Empirical Analysis" by Ahmed, Fairchild, and Guney (2020) addresses this exact question. In their theoretical framework, the authors show that under certain combinations of managerial risk-aversion, ability and overconfidence and conflict of interest with shareholders, corporate risk-management can turn out to be value-destroying. Firm value may be reduced by sub-optimal, inappropriate or unnecessary use of derivatives Ahmed et al. (2020). Especially, the authors emphasise the ambiguity of the relationship between corporate hedging and firm value and

firm performance, as hedging might show to be value-increasing or value reducing. Testing currency risk, interest risk and commodity price risk together, they get results that depict this ambiguity. Their empirical finding is that overall foreign currency hedging increases firm performance and value, while hedging of interest rate and commodity price hedging decrease both firm value and financial performance.

3.3 Hedging Practices Among Norwegian Electricity Companies

A few empirical studies on the risk management practices of Norwegian (hydro)power producers have been conducted. Sanda et al. (2013) conducted a study on the risk management practices in the Norwegian electricity commodity market. They analyzed 12 of the largest Norwegian hydropower companies, based on their written hedging policies as well as transaction data of futures contracts traded on Nasdaq. Almost half of the companies had also entered contracts in the bilateral market. Contracts for difference (CfDs), based on the difference between the system price and the area price, were used by some of the participating companies. The companies reportedly stated that these contracts were not suitable for hedging as they suffered from low liquidity.

Sanda et al. (2013) found that the companies were earning a substantial share of their profits from their hedging transactions. The companies also managed to reduce their cashflow at risk (CFaR), meaning they were successful at smoothing lower income levels. The variance of the cashflows and prices were also measured, finding that few companies were actually not reducing the volatilities. Enhanced risk appetite and periodically high basis risk (the risk that the system price which is the underlying for the futures contracts is different from the area price) are mentioned as possible explanations as to why the cashflow volatilities were not reduced. Most of the companies studied by Sanda et al. (2013) had hedging goals based on "ambitions to provide stable cash flows". The authors do however question whether companies might be using hedging not to increase predictability in cash flows but instead to increase profits. Though the companies made clear distinctions between hedging and speculation in their documents, an element of speculation seems to be present in most of them. They had a clear practice of incorporating market views in the hedging decisions. Most of the companies justified the use of selective hedging by competence on the energy markets and available risk capital.

Rønning and Skarsmo (2018) conducted a survey to map the attitudes towards risk of Norwegian power producers. They surveyed 38 power producers about their hedging practices, and conducted statistical tests and regression analysis on the data with hedge ratio. They were however only taking financial instruments into account in their statistical tests. Almost 87 % of the companies in the study report to hedging 50 % or less of their production, with almost 24 % reporting that the amount was between one and ten percent. 29 % had hedging ratios between 31—50 %. Almost 29 % of companies reported that

they did not hedge. Contrary to the empirical findings of general corporate hedging, Rønning and Skarsmo (2018) did not find a coherence between the size of a power producer and hedge ratio. No relationship was found between municipality ownership and hedge ratio, however, privately owned companies were found to hedge less (note that only five companies in the study report to being fully privately owned). 55.3 % of the companies reported having clearly stated hedging strategies.

The study finds the use of futures contracts to be the clearly dominant and preferred financial instrument for hedging. When asked to what extent CfDs were used, the answers on a Likert's scale with 1 indicating "to a very low degree" and 5 indicating "to a very high degree", averaged over all companies was 1.26. This is in line with the findings of Sanda et al. (2013). Under half of the queried companies reported using bilateral contracts, again in line with sanda.

3.4 Long-term Contracts in Electricity Markets

Over the most recent years, some studies have been conducted on the use of long-term contracts in different deregulated electricity markets. This section gives an overview of the reviewed literature on topics of this academic field.

Levelized cost of energy (LCOE) is the break-even cost of generation of each energy unit and can be an important component of a PPA price. L. Miller, Carriveau, Harper, and Singh (2016) evaluated the costs for wind power and discuss how PPA prices can be calculated using the levelized costs for the given project.

They found the LCOE to be sensitive to many factors, such as installation costs, but also many others that only are partially accounted for (operating costs) or typically excluded (transmission and environmental costs). The authors demonstrate that incorrect estimates of factors such as operation and maintenance costs and losses will significantly impact the LCOE for the project. They thereby demonstrate that a financially feasible project quickly could become unprofitable if estimates are off. Complicating the understanding of LCOEs connected to wind power production, L. Miller et al. (2016) discuss how no farm can be a 'representative farm'. Wind farm characteristics and management of them will play a significant role in the financial viability of each individual project, making simulation and LCOE calculation difficult.

Bruck, Sandborn, and Goudarzi (2018) developed a new cost model to evaluate the LCOE for wind power production that is under a PPA contract. They show its application to real wind farms, demonstrating that actual values for LCOE depends on defined minimum and/or maximum energy purchase limitations stated in a PPA contract.

The authors point out that previous models do not consider all the cost parameters in a wind farm under a PPA contract. PPA contracts may define a maximum or minimum annual power delivery limit, or both, and they argue

that these parameters must be considered in the LCOE model (while they are not considered in conventional models). Hence they add penalty to their model, which is the difference between the PPA price and the expected spot price, for power exceeding a limit, or represents the agreed upon penalty in the PPA for not reaching the lower limit (shortfall in the PPA). The cases of a minimum bound, or both an upper and a lower bound, of power delivered result in higher LCOEs. Further, lower CF's cause larger LCOEs, as they sometimes fall below the minimum threshold for annual delivery. Bruck et al. (2018) therefore argue that negotiating a "fair" PPA price is aided by including penalties when modelling prices.

Tranberg, Hansen, and Catania (2020) investigate the negative dependence between wind power production and electricity spot price in western Denmark, as this dependence can be an important fact to consider for risk management of PPAs. The authors construct a new model for pricing and risk management of long-term PPAs, using a score-driven model as a marginal model for spot price prediction. (Score-driven models are observation-driven models of time series data.) They compare it to the use of an ARMA-GARCH model developed for the same purpose, that had previously been published by Pircalabu, Hvolby, Jung, and Høg (2016).

The authors find that the score-driven model results in a statistically significant improvement of predicting Value-at-Risk (VaR), with VaR being highly important for risk management of long-term PPAs. Further, they find time-varying copulas (multivariate functions describing the dependence between random variables, enabling to create a joint forecast) to be significantly better than their constant counterparts at predicting VaR, making them favourable for risk management use. Ignoring dependence between the electricity spot price and wind power production leads to an underestimation of the VaR by 7.7 %, indicating the importance of taking the dependence into account when pricing wind power connected PPAs.

Use of PPAs in the Norwegian electricity market

Tungland (2012) researched the use of PPAs as a means to secure predictable long-term power prices for both producers and consumers in the Norwegian electricity market, by conducting interviews and gathering price data. Driving forces of entering PPAs were examined for holders of long and short positions, and the results show that though the consumers seemed to have the clearest fundamental need for the agreements, the driving forces were mainly coinciding. Consumers (mainly consisting of power-intensive industry) expressed a need for stable prices to minimize chances of unprofitable production. As the interviewed consumers had experienced reduced profit margins, this security was perceived as necessary to deal with fluctuations in the power price. Participating producers expressed in addition to the benefits of having predictable power prices, that securing dividend payments is perceived as an important task short-term rather than protection against long-term power price fluctuations. Further, the risk of not being able to meet delivery obligations due to unplanned stops in

production has to be considered when entering PPAs.

The price levels of PPAs in Norway is in this study explained to be determined by the prices of Nasdaq traded contracts for the first five years of delivery, followed by a price set by market analyses from other sources the remaining years. This is explained to some extent by price drivers being different short-term (with reservoir levels, reservoir inflow and temperature as important factors, together with a liquid financial market) than long-term (with low liquidity in the financial market). The price drivers in the market were expected to be well-known by all market participants. When examining expectations to price drivers influencing the power price, the consumers were found to focus on prices of coal, gas, el-certificates, CO_2 and costs associated with the distribution grid. Power producers would mostly focus on same drivers, and were also emphasising consumption and production levels and expected balance between the two.

4 Methodology

In this thesis I search to answer how power producers use financial derivatives and PPAs to hedge their production, and if it is possible to identify causes for the present changes in the use of PPAs and power futures for hedging purposes. Answers to these questions must be retrieved from the power producers by the use of the right research methods. It was of interest to conduct a study aiming to give deeper insight to a specific matter, and a qualitative research strategy was therefore chosen. This chapter gives an overview and explanation of the chosen methodology.

4.1 Choice of Research Method

Interviews are one of the most common methods used for data collection in qualitative research. Different types of interviews exist, but semi-structured interviews (where the interviewer does not strictly follow a list of questions) and in-depth interviews (intensive individual interviews on a specific topic, with a small number of respondents) are especially suitable (Tjora, 2017). Conducting a document study was also perceived as a possible research method. Document studies are another main category of tools for data collection, and often regarded as an unobtrusive method (a method minimizing the load placed on participants). Minimizing load on participants is a responsibility of all research, but though a document study could answer some of the questions of this thesis, this method would fall short in mapping the perspective on participants' motivation behind hedging decisions.

In-depth interviews
In-depth interviews was chosen as the research method for this study. They create a situation for a relatively free conversation that revolves around specific topics. The researcher has decided these topics in advance, but digressions are actually desirable, differentiating in-depth interviews from other research methods. This method also allows the use of open questions, compared to for example surveys, making the informant reflect on their own experiences and opinions related to the topic in addition to answering the prepared questions. For in-depth interviews to be successful, a relaxed atmosphere and a spacious time frame (preferably at least an hour) are important. (Tjora, 2017)

When recruiting participants for in-depth interviews it is important to carefully consider which type of respondents that have the desired knowledge and will be able to answer the prepared questions (a participant group called the 'strategic selection'). For this study, participants were chosen based on their relevant background in power companies.

For the data collection of this study, digital video interviews were conducted via Microsoft Teams. Nehls, Smith, and Schneider (2015) explore whether video-conferencing interviews could be considered an increasingly viable option for data collection in qualitative research. They emphasize benefits of cost-minimization and increased flexibility. Further, additional convenience, and a

rich 'face-to-face' experience were realized benefits of their study. The lack of an *actual* 'face-to-face' experience might however have significant impact, and Nehls et al. (2015) stress that the method is insufficiently studied at this point in time.

An interview guide was created with the research questions in mind. The interview guide (in Norwegian) is found in the appendix of this thesis. As stated by Yin (2003), it is important to formulate the questions unbiasedly. The questions were therefore formulated as neutral and objective as possible, while still trying to capture opinions and motivations for their practices. Before formulating the interview guide, the type of participants had been decided. The questions could therefore be tailored for the participant group of the study; risk managers or employees of power companies with similar roles. The first two minutes were reserved for an introduction of the researcher and the study. This was done to establish trust before starting the prepared questions. The interview guide further included visual 'probes' to stimulate conversation. These probes were in the form of graphs (figure 1 and figure 2), showing the development in PPA use and liquidity in the financial market.

4.2 Empiric Data Collection

Tjora (2017) argues that qualitative research creates closeness with the informants, so that the gathered data can become more nuanced. This was a clear intention of the way the interviews were conducted. Digressions were followed up by further questions if the participant was entering other relevant topics. The interview guide ensured that the interview would eventually get back to the intended topics. The interviews tended to need the spacious time constraint that was set, as most of the interviews lasted between 45 minutes and one hour.

The firms that were asked to participate in the study consisted of Norwegian power producers with over 1 TWh annual power production. To find these participants a list published by SNL (2020) was used, in addition to homepages of the power producers. The reason for this approach was to capture the overall changes in hedging behaviour in the Norwegian market. By interviewing the largest power producers in Norway, these main characteristics could be captured. Further, this choice would make it possible to compare results of this study with findings of Sanda et al. (2013), who previously had studied 12 large Norwegian power producers. 19 Norwegian power producers were asked to participate, which of 12 accepted. In total, these firms have an annual average production of 117.4 TWh. The participating firms are seen as representative for the industry, as they account for 77 % of the total annual production in Norway (see figure 3). The interviews were conducted over a period of 5 weeks, during March and April 2021.

Reasons for not participating in the study varied between the declining companies. Three of the asked companies did not reply after initial contact. The remaining of the declining companies replied, after having received the interview guide, that lack of time or demanding internal alignment were reasons for not

wanting to participate.

Near the end of my thesis work, a presentation of the study was held for all participants in a plenary online session. This gave the participants a chance to give comments and ask questions. Their feedback resulted in some final adjustments being made on the thesis. This online presentation also strengthens validity as participants got the chance to sort out eventual mistakes.

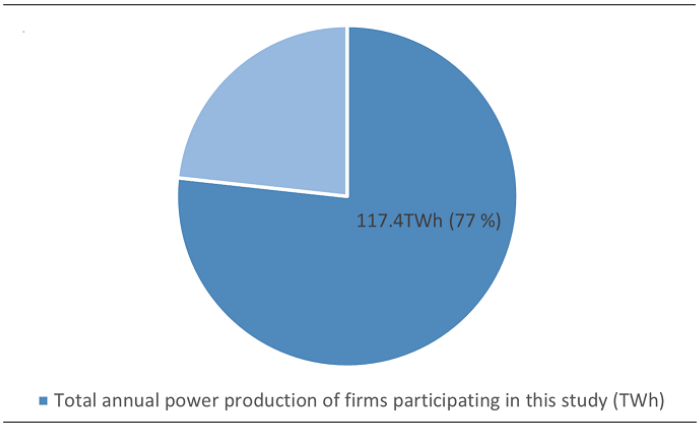

Figure 3: Sum of the total power production of the 12 firms participating in this study (TWh), as part of total production in Norway[3]

Quality of the research

Reliability (to what degree the research method produces stable and consistent results) and validity (how well a method measures what it is intended to measure) are important criteria when assessing the quality of qualitative research (Tjora, 2017), (Bryman, 2015). A reminder that interviews cannot ensure accurate information is due. If accurate information is crucial, another source of information (preferably written) should be used to check answers that are given. However, subjective factors were considered to be the most important in this study. Measures were taken to strengthen the reliability and validity of empiric findings. The interview guide with planned questions for the interview were sent to participants in advance to give them a chance to prepare. This also gave participants the chance to decline participating if they did not feel comfortable with answering the questions. All interviews were recorded, with consent, to ensure that information and quotes would be represented accurately in this thesis. Lastly, the length and questions of the interview was first tested on a participant willing to give feedback before the other interviews were conducted.

[3]Total annual production for Norway based on https://energifaktanorge.no/norsk-energiforsyning/kraftforsyningen/

5 Empirical Results

The empirical findings of the conducted interviews are presented in this chapter. These findings are related to the hedging practices of the firms, focusing on the prevalence and development in use of PPAs for hedging purposes. Found changes in use of financial derivatives, and attitudes towards hedging in general, are also presented.

For all companies, a portfolio used to hedge the price risk of their power production was considered as the hedging portfolio. Such a portfolio consists of short positions in Nasdaq traded futures contracts, other financial derivatives and PPAs. This portfolio is subject to the hedging practices presented in this chapter.

5.1 General Hedging Practices

All 12 companies had a written hedging policy that described management and principles of the hedging portfolio, and also the goals of their hedging activities. The mentioned goals of their hedging (not obtained directly from the written policy, but by as explained by the participants) were mainly related to the smoothing of cash flows and avoidance of short-term low-income scenarios. Interestingly, creation of profits was also explicitly stated as a hedging goal for some companies, with one company formulating "beating the spot price" as one of their main goals.

The motivation of profit creation was also found in explanations of the companies' practices. 11 of the 12 companies reported using their market views in hedging decisions. All companies that were hedging were therefore applying market views, as one company did not currently hedge any of its production. Use of market views in this manner is referred to as 'selective hedging' in the risk management literature. And though the practice of selective hedging seems inconsistent with traditional theory on risk management, as it implies a wish to create profits from the use of market views whereas the goal of hedging would normally not be to create profits and, it is previously found to be widespread (Brown, Crabb, & Haushalter, 2006), (Bodnar, Hayt, & Marston, 1998) and (Glaum, 2002). The firms, however, need to be careful when making decisions based on their market views. If caution is not advised, selective hedging can in the worst case lead to bankruptcy as Stulz (1996) shows in his paper by some real-life examples. In less extreme cases, "the cash flow gains from selective hedging appear to be small at best" (Adam & Fernando, 2006).

Most participating companies' motivation for engaging in selective hedging was driven by the fact that they had internal or external analyses of price developments that differed from available prices in the futures market. A wish to beat this price level was therefore present, and implications of this will be explored below. Two companies also had different portfolios used for hedging the production, and within these had specific portfolios for attempts at creating profit on hedged production.

As stated limits for hedging in the policies, the majority of the participating companies (9 of the 12) used some sort of specified hedge ratio requirements. Of these, most had a time-to-maturity dependent hedge ratio. This practice is in line with the previous findings of Sanda et al. (2013), for the industry. However, two companies made hedging decisions solely based on their needs and market views in different price scenarios, and the last company of the 12 did not currently hedge any of its production. Two companies revealed plans to remove existing lower hedge boundaries and incorporate a cashflow-at-risk (C-FaR) approach to decide limits of their hedging activities. This change in hedge ratio requirements was by the participants also motivated by a wish to use market views to a greater extent, underlining the observed gap between price expectations and available contract prices.

5.2 Use of PPAs for Hedging Purposes

Of the participating companies, 9 had at least one active PPA. Table 1 shows the percentage of (expected) annual production that was sold through PPAs the current year, for all participants, listed in random order. The length of these contracts varied from 1 to 20 years, clearly exceeding futures contract lengths available at Nasdaq. Some PPAs were connected to wind power production, but this was not the case for all agreements within the companies of both wind and hydropower production. Also pure hydropower producers had entered PPAs. Of the three companies without an active PPA, two of these were pure hydropower producers. Some main characteristics were identified for the agreements' contents: The vast majority of the contracts were on base-load delivery (constant volume of delivered power), while some were on delivery 'as-produced' or of other delivery characteristics. The agreed price was for most PPAs a fixed price, but there were also instances of CPI adjusted prices and other price characteristics.

In accordance with reports on PPA use introduced in chapter 2, agreements connected to wind power production had for some participants been necessary to obtain financing for the project. This lowered the minimum requirements for price the producer would accept when entering a into a contract. Using a systematic pricing method was however found to be rare among the companies. Lower price than their expected future power price, or lower than the prices available on Nasdaq was by few accepted. For most, negotiating a PPA was perceived as a chance to achieve a higher price than the price available in the financial market.

Production sold through PPAs	Duration
14 %	7–12 yr
0	n/a
5–14 %	7–11 yr
8 %	10 yr
17 %	7 yr
n/a	7–20 yr
0	n/a
n/a	3–4 yr
5 %	1–3 yr
n/a	n/a
10 %	20 yr
0	n/a

Table 1: Part of production (% estimate) sold through PPAs by the participating companies.

5.3 Discovered Changes in Bilateral and Financial Contracting

A trend where more companies were entering into PPAs was observed. More precisely, the trend can be said to be *confirmed* by this study, as the finding is in line with the previously reported change by Energy Brainpool (2018), Copenhagen Economics (2020), THEMA (2021) and (Oxford Energy, 2021). When asked, 5 of the 12 companies reported on having changed their use of PPAs towards entering more agreements in recent years, and/or changed their attitude towards using the agreements for hedging purposes, towards viewing them as more suitable for their need, or being more attractive than previously. In comparison, the preceding studies conducted by Sanda et al. (2013) and Rønning and Skarsmo (2018). They both found that under half of the participating companies of their surveys used bilateral contracts for hedging. A conclusion on changed hedging behaviour cannot be made on the direct comparison of these studies, as different companies were participating in the studies. The comparison and the fact that 9 of 12 participants in this study had active PPAs suggests however that there has been an increased effort taken by power producers to search for relevant counterparts over the last years.

Though the reviewed reports in chapter 2 list some benefits of using PPAs for hedging purposes compared to power futures, multiple other motivational factors were discovered in this study. Not only is the increase of PPAs tied to wind power and electricity intensive industry, but the agreements have several features that are also favorable to traditional power producers. The following list is compiled of all experienced benefits of PPAs, as mentioned by participants in the conducted interviews:

1. No collateral requirements, and no costs tied to clearing
2. Having a long-term hedging instrument is useful
3. Poor liquidity in the financial derivatives market
4. No exposure to the risk of varying area price – system price difference
5. Needed a PPA to secure financing for a wind power project
6. Favorable tax regulations for agreements with industry, that fulfull special requirements ('Industrikraftavtaler')
7. Being able to have a tailored agreement, with the possibility to have added values if desired
8. A tool to stimulate business in their region: A participant wanted to establish consumption by incentivizing local industry
9. 'Own use exemption' (IFRS)
10. Possible to negotiate what is perceived as a "fair" price, in comparison to standard prices of financial derivatives
11. Management of PPAs is experienced as less time consuming than using financial instruments to hedge

Multiple of the stated benefits are directly tied to the costs of hedging. Item (1) on the list addresses the benefit that was emphasized most by the participants of this study. The vast majority mentioned some version of "hedging using financial contracts is expensive". Financial hedging does in addition to the direct transaction costs (which are minor), bind up substantial working capital. The requirement of collateral was experienced as one of the main costs of the derivatives. Further, (3) and (10) together demonstrate the found gap between expected future power prices and available prices on the exchange. An answer of the possibility "negotiate a fair price" was mostly followed up by "in contrast to Nasdaq prices".

There were different levels of concern for varying difference between area- and system price (4), but reportedly little to do to protect against this risk. The liquidity of Electricity Price Area Differentials (EPADs – Contracts for Difference (CfDs) at Nasdaq) is especially low. The concern was found to be larger for power producers located in the north of the country and relatively minor for producers in the south. This is expected as area prices at the time are higher in the southern price areas, due to reasons that will be discussed in the following chapter. The use of PPAs and OTC CfDs were the tools used by the participants to mitigate the basis risk, and one participant mentioned the possible introduction of transmission rights as a desirable tool for future hedging.

Tax and regulations
The items (5) and (9) on the list of benefits above refer to the regulations that differ for financial derivatives and PPAs. An explanation of tax and other relevant regulations for PPAs is therefore due.

There are multiple regulations that distinguishes PPAs from financial derivatives. For some PPAs sold to industry by a contract of at least 150 GWh, lasting at least seven years ("industrikraftavtaler"), tax is calculated from the contract price (Skatteetaten, 2018). The producer's counterpart must for this be accepted as an offtaker that fulfils certain requirements. Around half of the participating companies had agreements that were applicable to this tax regulation. This can be beneficial for a producer as tax regarding financial derivatives are valued on the basis of the spot price. A loss on a financial contract will then result in reduced profits as well as a relatively higher tax.

Other international financial regulations are only adding costs for financial products (which also includes financial PPAs). MIFID II 26 states the obligation to report transactions is not applicable for physical PPAs (Copenhagen Economics, 2020). Regarding IFRS (accounting standards), PPAs are exempt from the IFRS 9 (regarding classification and measurement of financial assets), if it classifies for the own use exemption (IFRS, 2021). There are today seemingly few such regulatory barriers to PPAs on physical delivery in Norway. (ESMA, 2021)

Day-ahead auction at Nord Pool, which set the system spot price, also has a variable cost of 0.046 EUR/MWh that applies to power producer. This cost consists of two low fees; 0.04 EUR/MWh for day-ahead auction and 0.006 EUR/MWh for a settlement fee (Nord Pool, 2021). Power sold through PPAs thus saves the producer this cost.

Important shortcomings of PPAs
Disadvantages of PPAs were also discussed in the interviews. Mentioned reasons for preferring financial, Nasdaq traded contracts to PPAs were the following. For most, the lack of transparency was regarded a disadvantage of a continued widespread use of PPAs. Contract details and volumes of contracts are as mentioned above exempted from enrollment in official registers. The transparency of the financial derivatives was appreciated by the participants, and as the price is set by the market it is perceived as the right and just price, though it might be lower than the companies' price expectations.

Credit risk was the second most frequently mentioned disadvantage of a PPA in the interviews. All participating companies with PPAs acknowledged the risk, and did to some extent practice evaluation of credit risk associated with a counterpart before entering an agreement. The companies had different methods of assessing and managing this risk. These were classification systems or a list of eligible/non-eligible counterparts. The systems were based on the use of available external credit ratings and/or internal analyses.

However, the case of Einar Aas' failure to meet his contractual obligations

with Nasdaq in 2018 was almost brought up as often as credit risk tied to counterparts of bilateral agreement. This case is about the power market trader Einar Aas who got in trouble during fall 2018 and consequently went bankrupt[4]. As he could not could not cover the losses, clearing members of Nasdaq were heavily economically affected. It seemed to the author of this thesis that the credit risk associated with bilateral agreements was actually not perceived as significantly larger than credit risk associated with the exchange traded contracts. This is surprising as the collateral required, together with other regulations, should provide the power producers with the assurance of trade being relatively credit risk free.

Lastly, an additional cost of negotiation due to a time consuming process of finding fitting counterparts for a PPA was stated as an important disadvantage. The agreements were experienced to be a lot more time consuming in the initial phase of the contract, with financial derivatives being straight forward in this aspect. Overall, the PPAs were however regarded as less time consuming. When the agreement has been signed, there is no daily clearing over the course of the contract length. Managing the contract is then preferred to the management of a financial contract, as item (11) in the list above shows.

[4]See: https://www.nrk.no/norge/kraftmilliardaeren-einar-aas-konkurs-1.14206912

6 Discussion and Analysis

The conducted interviews confirmed a trend where power producers hedge less by the use of Nordic power derivatives, and are increasing their use of PPAs. A changed attitude towards PPAs was also found, resulting in the compilation of a quite substantial list of experienced benefits of using these agreements for hedging purposes. Finding counterparts for the long-term agreements is however not an easy task, and PPAs are like financial derivatives not the perfect hedging instruments. This chapter seeks to answer the research questions of the study. The chapter will therefore investigate the changes in general hedging practices of Norwegian power producers (6.1), motivation for transitioning from the financial to the bilateral market (6.2), and the importance of a functioning financial market (6.3).

6.1 Changes in General Hedging Practices of Norwegian Power Producers

General hedging practices of Norwegian power producers were mapped in this study to enable identification of changed behavior, and to enable comparison with previously conducted studies on the topic. In general, findings of this study largely coincide with the previously found industry practices by Sanda et al. (2013). Norwegian power producers still regard Nordic power derivatives at Nasdaq as their main hedging instrument, and practices of applied hedging ratios or 'cash-flow at risk' approaches are still primary approaches. However; motivation towards, and use of, PPAs has changed since their survey was conducted.

In their study, Sanda et al. (2013) found that selective hedging practices were extensive among their sample companies. Their suggested explanations for this were enhanced risk appetite and periodically high basis risk (the risk of mismatch of the area price and the hedge based on the underlying system price). The findings of this study substantiate that selective hedging is a widespread practice among Norwegian power producers, as all participating companies that were hedging reported on incorporating market views in their hedging decisions. The empiric results of this study show that some power producers are changing their practices towards removing lower hedge ratio boundaries or changing hedging approaches. This might be done for two reasons. 1) It may be motivated by a wish to hedge less, or 2) it might be done to facilitate the use of market views to a greater extent. Both reasons seem plausible by the findings of this study. A less liquid market, which is the situation at this point in time, with higher costs and collateral requirements, can be reasons for wanting to hedge less. This reason also includes companies with a decreased need for protection against price risk. The other possibility, an increased of use of market views, was stated directly by some participants, and is done to create profits. Both reasons seem to fit with the overall trend found by (Sanda et al., 2013), mentioned in the introduction of this study: That the distinction between hedging and speculative trading seems to be partially erased in the market today.

The found practices raise the question of why risk management practices within the industry are changing. If the mix of hedging and speculative trading is prominent, what change in behavior does it cause? And how is this practice tied to the current status of the financial market? As Sanda et al. (2013) found, hedging can be beneficial for the power producers, with their study showing that derivative cashflows constituted substantial profits for the companies. Power producers today might seek to capture this profit more than previously, and are hence willing to take larger risks by hedging less.

6.2 What Motivates Power Producers to Transition From the Financial to the Bilateral Market?

As presented in the introductory chapters of this thesis, recent reports have shown an increase of PPA use in the Nordic countries as well as in the rest of Europe. The reports especially focused on Environmental, Social and Governance (ESG), construction of data centres and investment in renewable energy as the main drivers for the increase in signed PPAs. In particular within the renewable energy investments, PPAs are to a high degree tied to the rapid expansion of wind power projects. On the seller side of the contracts, wind farms have dominated signings of new PPAs in recent years (Copenhagen Economics, 2020). This study finds that traditional power producers are also playing an important part of the current developments, as they have are changing their hedging practices towards increased use of PPAs.

What has motivated them to embark on this transition? Some of the participants' increase in PPA use was tied to wind production, and some participants mentioned increase in focus on added values. The participants emphasized that focus on guarantees of origins (GOs) was yet experienced to be minor in the Norwegian electricity market. The focus on additional values had really changed from "an almost non-existing focus to a minor focus". Other European countries have experienced a higher demand for GOs, and this might be because of consumers focusing on the provable new renewable capacity they support. This effect is then a more viable solution in a country with less electricity coming from renewable sources to begin with, compared to the high renewable energy portion in the Norwegian market. GOs can however be an extra source of income for the producers of renewable energy, as they constitute about 1 % of the wholesale power price (Copenhagen Economics, 2020). The participating companies were therefore expecting them to become more important in the near future.

For the power producers making up the sample of this study, the focus the agreements' importance in the industry is found to be somewhat different then the focus areas of the reports. In addition to the reasons of Copenhagen Economics (2020), Oxford Energy (2021), THEMA (2021) and Energy Brainpool (2018), multiple others were discovered. The list of mentioned benefits of PPAs presented in the previous chapter is quite extensive. Being a long-term hedge is a trait of the PPA that for the wind projects is especially important, while

many of the reasons relevant to a hydropower producer are tied to prices and costs, in the sense that PPAs actually seem more favorable. For power producers, dealing with daily clearing, required collateral to trade derivatives and a financial market with low liquidity is not the best imaginable hedging situation. In the bilateral market, a company has the chance to negotiate a better price, or a price they for some subjective reason perceive as "fair". As this thesis investigates, the focus on profit creation while hedging can be a driving factor to start a search for a counterpart for such an agreement. The interviews found that there is a significant gap between available prices and price expectation of the participants. The price curve of Nasdaq was viewed as the absolute minimum price for an agreement, but participants argued that they expected significantly higher power prices in the future than the price of the futures contracts. This further explains their motivation to search for counterparts in the bilateral market, and hence hedge less using financial derivatives.

One of the benefits of a PPA that deserves extra attention is the ability it has to mitigate basis risk. An observation was made in this study that there is increasing worry about price difference between system prices and area prices. Today, the price difference tendency shows areas in the north of the country (especially 'NO4') having a significantly lower area price (spot price) than in the southern part of the country. This difference is seen due to production and consumption, with limited connection capacity across borders of the country. Wind production has especially expanded in the north of the country. New subsea interconnectors (cables) have been built, like the Norway-Germany 'NordLink'[5] put in operation May 2021, and the Norway-Great Britain 'North Sea Link' planned to be completed in 2021[6]. These cables, as well as other previously existing cables, are connected to the southern part of Norway, in price area NO2. Because then of production in the north of the country being restricted to reach more southern locations, by grid capacities being met at current production levels, these bottlenecks contribute to price differences. A PPA agreement made with a consumer on a price of delivery, not dependent on system price, removes this basis risk. In times of high differences, a price agreement that removes this risk exposure, can be very valuable.

With the increased basis risk, the system price becomes less important to the power producers. Since the system price is the underlying of the power futures, these futures then also become less relevant. The power producers who want to mitigate the risk, must largely do so by signing PPAs as liquidity of EPAD contracts is low. However, the Norwegian Energy Regulatory Authority will be able to take action. The FCA guidelines, that state measures should be taken to ensure sufficient hedging opportunities, suggests the use of transmission rights (European Union, 2016). Transmission rights entitle holders compensation for congested transmission lines, which is the cause the price differences, and are issued by the TSO (the transmission system operator). There is at the present

[5] https://www.statnett.no/en/our-projects/interconnectors/nordlink/
[6] https://www.statnett.no/vare-prosjekter/mellomlandsforbindelser/north-sea-link/

time a decreasing availability of the main tool (EPADs) to mitigate basis risk, while the prevalence of this risk has been increasing. Some of the electricity companies studied therefore expressed interest in trading transmission rights if they become available.

Tax and regulations were presented in the previous chapter. There are multiple regulations that differ for the contract types discussed in this thesis, and there are today seemingly few regulatory barriers to PPAs on physical delivery in Norway (Copenhagen Economics, 2020). The power producers are found to be very aware of the PPA benefits on taxes, consequently seeking to maximize the cost savings they enable. The cost related to day-ahead auction and settlement at Nord Pool is presumably of minor importance, while especially tax savings on PPAs sold to industry ('industrikraftavtaler') were frequently brought up as an essential motivation factor for PPA signing. Overall, tax and regulations are in sum making up an important share of PPA benefits, and hence they make up a possibility that regulatory authorities has to influence the current situation.

How well do PPAs and Nordic power futures coexist in a hedging portfolio?
PPAs are often signed on baseload delivery. This was also the most common delivery characteristic used by participants of this study. Using baseload delivery means that varying production and demand throughout the year is not captured by the contract. Futures on the other hand, can more easily be traded to customize expected seasonal variations, by trading contracts based on shorter delivery periods. This enables the company to have a hedge ratio that is relatively constant as power production and consumption naturally changes throughout the year.

Of course are neither power futures nor PPAs the perfect hedging instruments. As presented, finding suitable counterparts. Some participating companies of this study wanted to sign more bilateral contracts, but had not found counterparts in the industry willing to enter an agreement. A long-term contract can also mean loss for a producer over a longer period of the contract length if power prices were to increase. A PPA is of course not an agreement that guarantees beneficial terms for any of the involved parties, and negotiating the price is not an easy task. Standard pricing methods are in this study found to be rare in the industry, making this important process tied to uncertainty. Are multiple PPAs signed in a short time interval, risk of losses due to increases in price over longer periods of time is present. A power producer experiencing this might biasedly avoid PPAs in the future. A way to mitigate this risk is for the power producers to sign PPAs at different points in time, to capture some of the long-term price changes while hedging short-term fluctuations.

It is further worth noting that while almost half of the participating companies reported on changed behavior or attitude towards PPAs, the other half of the companies is an important part of the overall picture. Even with overall changes in the industry practices, some companies have not increased their use

of PPAs at this point in time. A change towards increased use of PPAs is not found to be happening at a fast pace, and this could give the market a chance to adjust, and maybe also predict consequences the changes that by found indications are present.

6.3 The Importance of a Functioning Financial Market

A market with poor liquidity makes risk management difficult for the market participants. According to financial theory, one would not expect the creation of profits to be a goal of hedging. One would instead expect power producers to accept a lower price for sold electricity, wanting a more stable cashflow in return. The found practices indicate that the market participants may not be willing to accept the traditional meaning of hedging. They see the potential of creating profit, and their behavior can therefore seem more similar to trading than to hedging. Hedging has for power producers become more expensive by new regulations in the years following the financial crisis, and there are today larger costs for trading, as will be discussed below. Further, the lower liquidity indicate a downward spiral in attractiveness of the financial futures market. Some power producers are also found to be hedging less than previously, contributing to this development.

Trust

Has the level of trust in the financial market weakened? The case of Einar Aas' bankruptcy was briefly presented in the previous chapter. Regulations and collateral requirements have since the financial crisis been reviewed, and further reviewed after the case of Einar Aas in 2018. This has resulted in in a market that should carry less credit risk today.

For someone not aware of this past incident, he or she would quite naturally assume that a benefit of using Nordic power derivatives for hedging, compared to the use of PPAs, would be protection against credit risk. The collateral and regulations should protect the traders of futures contracts against a counterparts' default. Some participants of this study also argued for this point of view. Nevertheless, the case of Einar Aas seems to have caused a loss in trust towards Nasdaq, that has not been regained by the structural improvements. The story of his bankruptcy was frequently brought up by participants during interviews, especially when comparing credit risk of bilateral agreements to the exchange traded futures. One participant shared a personal view on related credit risks to the contract types, and it was the following; If a counterpart in a PPA defaults, they lose the protection against varying electricity price, but they will then sell the power on the spot market instead. In the case of facing default by a counterpart on Nasdaq, they risked losing millions due to the unfulfilled contract terms.

The findings of this study actually suggests that the theoretical protection against credit risk that the exchange provides, is now less significant for a power producer when deciding between financial and bilateral contracts, as the level

of trust towards Nasdaq has weakened. And this trust has proven to be hard for the exchange to restore.

Society's interests

What is the importance of a functioning financial market? If the trend towards the use of more bilateral agreements continues, and trading on the Nasdaq exchange continues declining, the existence of the financial market is uncertain. This implies not only consequences that power producers will face, but that will affect society.

Forward prices reveal otherwise unobtainable information about the future price of a commodity (McDonald, 2013). The financial market of power futures at Nasdaq provides the value of future delivery of power. Futures prices are used for benchmarking other contracts in the market today, like PPAs. Further, the prices are used for valuation of companies, and are used by power producers to create price scenarios and to decide dispatch from their reservoirs. It is apparent that the information obtained from power derivatives prices is essential for market functionality. The information is also essential for the public, especially in this time of electrification. The public does not contribute to the market functionality and are in this perspective 'free-riders', who benefit from resources they do not pay for.

The use of PPAs build on prices that are not obtainable to the public. Without a well-functioning financial market, there is no accessible information on value of future delivery of power. While the spot market and the bilateral market will ensure the delivery of power and prices in equilibrium of the demand and supply in the market, risk management will become harder for the producers and the consumers, and this would largely complicate operation in many industries.

Indications of the current market status

Directing the focus back to PPAs' market influence, it is evident that the financial market of Nordic power futures is struggling, and that Norwegian power producers are adapting by trading less on the exchange. An increase in PPAs has emerged not only by an increase in wind power projects, but also due to traditional power producers changing their use of the available hedging tools for their hydropower production. Together with currently high differences between area and system prices, with expected continuous tendencies in sight, the changes in the financial market can quickly amplify. A threat to the existence of the futures market seems by this to be present.

The financial market finds itself in a vicious circle. Less liquidity in the market causes the market to be less attractive to participants, causing an even less liquid market. Just before the financial crisis in 2008, trading volume at Nasdaq Commodities for the power futures was around 7 times the underlying production. Since then, liquidity has been declining until last year. In 2020, the trade volume did increase somewhat (Nasdaq, 2021). During this year, there was both uncertainty tied to the Coronavirus pandemic, and also unusually low power prices. Generally, it is assumably the case that a period of increasing

volatility also increases trading on the exchange. A period of low power prices over time will however likely cause a decrease in trading, as power producers in this situation are less likely to do investments, and hence are not as dependent on hedging.

Future prospects

What are solutions available to the struggling exchange, to increase liquidity? And how should a power producer approach hedging in the market with the current situation? These are hard questions to answer. As Webb (2018) stated, there have been both spectacular successes and costly failures within the world of derivatives markets over the last 50 years. It has rarely been possible to predict them, and though success factors can be identified, influencing the market interactions is difficult. Success is also often transient, where change in market situations can eliminate the need for even heavily traded contracts.

A power producer might wish to search for contracts in the bilateral market that are competitive with a hedge consisting of futures, and in some aspects also achieve this. However, PPAs and futures make up a good match in a hedging portfolio, catering different needs. PPAs on baseload delivery assure a long-term hedge and reduce basis risk for the producer as two important functions. The baseload structure can be adjusted with financial contracts to fit a seasonally dependent production pattern. With the ability of futures to more quickly readjust hedge ratios, the two hedging instruments complement one another – as long as the futures market stays intact.

Some participating representatives expressed little unrest over the market situation, whilst others seemed convinced that the situation of the financial market was soon beyond a tipping point. This belief will probably influence hedging decisions, potentially amplifying the current situation. The expectations to the market, as a market where one can both hedge production and create profits simultaneously, which was more present, also seem to contribute to less use of the financial derivatives. Plausible future prospects are continued growth in signed PPAs, connected in greater share to hydropower production, and a continuously decline in Nordic power futures. Periods of higher volatility, other arising needs for producers or consumers to hedge more, or an increase of speculators in the market could slow or even turn the developments in the financial market.

7 Conclusions and Policy Implications

The problem area analyzed in this thesis was the increase in PPA use and the simultaneous decrease in trading volume in the financial market for Nordic power derivatives over the recent years. Specifically, the behaviour of Norwegian power producers in these markets was analyzed. 12 power companies were interviewed, together accounting for 77 % of the annual power production in Norway. The aims were to map their motivations for (increased) PPA use and to identify some implications for future market functionality.

The findings of this study confirmed an increase in the use of PPAs for hedging purposes among the power producers, higher than previously reported levels by (Sanda et al., 2013) and (Rønning & Skarsmo, 2018). The motivation for signing these long-term hedging contracts was also found to have increased over recent years. 5 of the 12 interviewed power companies reported on having changed their use of PPAs and/or their motivation. They were signing more contracts or wanted to sign more. Another main finding on general hedging behaviour was that the hedging goals of Norwegian power producers seem to distinguish little between hedging and speculative trading. Power producers stated creating profits as a goal of their hedging activities, and all companies that were hedging were incorporating their market views in their practices. Reasons for this behaviour can be explained by a wish to hedge less, or is being done to facilitate profit creation, due to the found gap between price expectations and available prices in the market.

Power producers perceive PPAs to be very beneficial for hedging purposes. This thesis compiled an extensive list of experienced benefits. While PPAs are, according to previous research, an important long-term hedge for wind power projects, many benefits are also relevant to a traditional hydropower producer. The benefits are tied to prices and costs, in the sense that PPAs seem more favorable: No daily clearing, no collateral and the low liquidity in the financial market are found motivational factors to hedge by PPAs. The focus on profit creation from hedging was also found to be a driving factor to signing these agreements, as they give the opportunity to negotiate a price they view as 'fair', while they experience that this is not the case in the financial market.

PPAs also serve as an instrument for mitigating basis risk. This risk was found to be of increasing concern for power companies in the north of the country. Financial derivatives for mitigating this risk (EPADs on Nasdaq) are especially low in liquidity and were viewed as an insufficient hedging tool by the power companies participating in the study.

A well-functioning financial market serves power producers as well as the public in general. Without a financial market for power derivatives, there is no accessible information on value of the future delivery of power. This information is crucial in this time of electrification.

Some of the participants expressed concern for the current market situation.

The liquidity in the market has been decreasing over the last decade, reaching a level that makes power producers become reluctant to trade in this market, due to the large gap between expected an available prices. The trust in the financial market has also weakened since the incident of Einar Aas in 2018. The findings of this study actually suggests that the theoretical protection against credit risk that the exchange provides, is now less significant for a power producer when deciding between financial and bilateral contracts, as the level of trust towards Nasdaq has weakened. Some participants questioned the futures market's continued existence. Hence, this thesis serves as a warning signal on the current status of the financial Nordic power futures market.

The FCA guidelines (stating that the financial markets should be able to provide sufficient hedging opportunities for market participants) are expected to be implemented by the Norwegian government[7]. The findings of this study point towards the need of implementing such measures, as the hedging opportunities seem to be insufficient. Plausible future prospects of the market status, by the findings of this study, are continued growth in signed PPAs and a continued decline in trade of Nordic power futures. Periods of higher volatility, an increase share of speculative trader in the market, or the introduction of policies assuring better hedging possibilities, could turn the developments in the financial market.

7.1 Important Notes on the Findings of this Thesis

The assumptions and simplifications made in this study were stated in chapter 1. The limitations and possible pitfalls of the empirical research have also been discussed, in chapter 4. The main points of focus within this topic were revolving around the validity of the responses and their representativeness. Some further comments should still be made on the results of this study to ensure they are interpreted in the right context.

Only a selection of power producers were interviewed for this study. The overall results can therefore be influenced by views that do not represent the entire industry of power producers. Further, there exists a risk that answers from the participants might not represent their companies well either. Within a company many different views and opinions will be held. The answers can in this way be biased by the respondent's views more than this study has accounted for.

Further, this study was conducted by investigating traditional power producers. A substantial amount of the capacity that has been installed over the recent years is wind power in cooperation with foreign investors. If one desires to get a complete picture of the developments in PPA use, these investors should also be included. This study focused on the hedging practices of Norwegian power producers, and they were hence left out. Their importance is however indisputable for market functionality and future design. This study was also

[7] https://www.nve.no/reguleringsmyndigheten/europeisk-regelverksutvikling/europeiske-nettkoder-og-retningslinjer/retningslinjen-om-terminmarkedet-forward-capacity-allocation-fca-gl/?ref=mainmenu

conducted based on some of the findings in the reports introduced in chapter 2. Meaning that if these reports contain inaccurate information, this will have influenced the facts stated in this thesis. Especially, the information about PPA trends and trading volume on Nasdaq have been important for this thesis. The data on total volumes of PPA is difficult to replicate. The data on Nasdaq trades is however confirmed directly from Nasdaq's annual reports to ensure their validity.

7.2 Future Work

In this final part of the thesis, some possible future work is proposed. These suggestions are intended for academic researchers and the industry, for a continuation of work on the findings of this study. Especially regarding application of the FCA guidelines, further research should be conducted to fully understand how improvements of the hedging opportunities could be implemented.

This study was focused on Norwegian participants. However, the Nordic market is tight-knit, and including power producers from the other Nordic countries would give a more complete picture of the practices and market situation. In this thesis, the assumption has been made that the results are somewhat generalizable to the rest of the Nordic power market. In figure 1 in chapter 2 it can be seen that a substantial amount of PPAs are signed by Norwegian actors, and Norwegian market participants are hence assumed influential on the overall market. Hedging culture could still be quite different in other countries, making the results differ. The assumption of representativeness could be verified or dismissed of a study including additional Nordic participants outside of Norway.

Another interesting aspect is PPA use among smaller power producers. This study was focused on the largest producers in Norway, for the purpose of capturing the overall changes in the industry. Hence only producers with over 1 TWh annual production were asked to participate. A relevant question to answer would be the question of whether small power companies have different hedging practices than the larger ones. While preparing to conduct this study there were identified just below 40 power companies with over 0.1 TWh of annual production in Norway. Including even smaller production, it is clear that the amount of companies applicable for such a study is quite large. Finding if their operations are run on a larger or smaller degree of use of financial derivatives or PPAs could be valuable information.

Several questions remain unanswered in the current market situation. When evaluating the hedging trends and its causes, the following questions might be answered in the future: How much will current PPA use, or further increased use, affect the financial market? Could this development become critical for this market? Lastly, I want to raise the question of whether PPA use could also influence the spot market. Little academic research seems to exist on this topic, and if PPAs become the part of the market where a predominance of power is sold in the Nordic market, this question will become of great importance.

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Appendix

Interview Guide – Intervjuguide

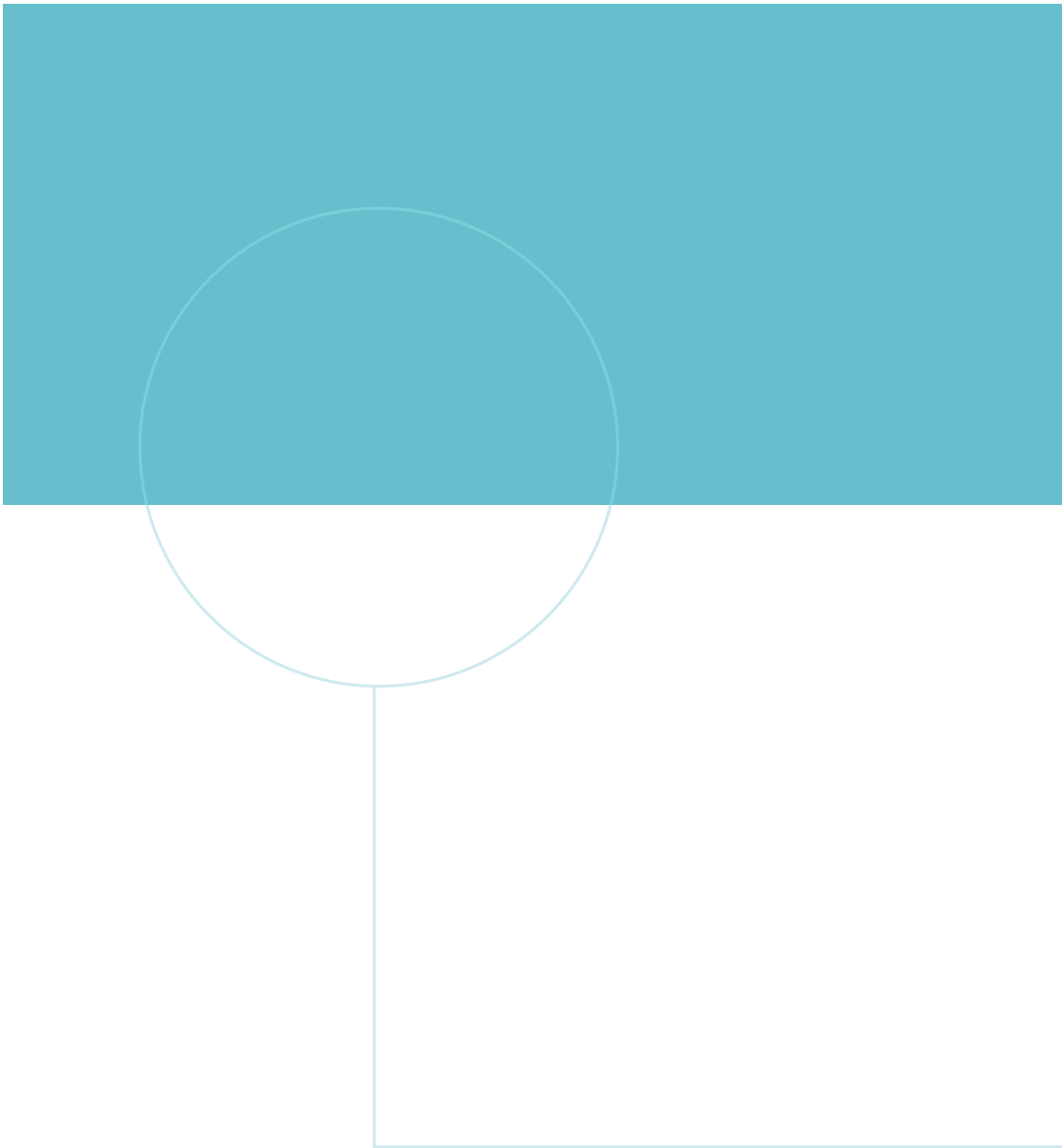
Generelle spørsmål om sikring:

1. Har dere en skriftlig sikringspolicy? (Ja/Nei)
   (a) Hvilke punkter inneholder den?
   (b) Inneholder den en spesifikk sikringsgrad dere har som mål å ligge på? Ev. et område for sikringsgrad?
2. Hva kan beskrives som målet med sikringen dere gjennomfører?
3. Brukes markedssyn i forsøk på å hente merverdi gjennom sikring?
4. Hva er omtrentlig fordeling mellom de ulike sikringsproduktene i sikringsporteføljen (PPA, finansielle kontrakter med levering år, kvartal, måned, uke)?
5. Har bruk av tradisjonelle finansielle derivater handlet på Nasdaq mot bruk av bilaterale avtaler endret seg hos dere?
6. Har synet deres på de tradisjonelle finansielle kontraktene endret seg?
7. Sikres valuta? Hvis ja, hvordan bestemmes mengde som sikres?
8. Områdeprisrisiko: Hva gjør dere for å sikre dere mot denne risikoen?

Spørsmål om bilaterale avtaler:

9. Hvor mange aktive bilaterale avtaler har dere per i dag? Både avtaler med levering nå og med kommende levering.
   (a) Hva er volumet på avtalene? (Prosent av total årlig produksjon)
   (b) Innenfor hvilket intervall ligger lengdene på levering for disse kontraktene?
   (c) Er det industrikraftavtaler?
10. Hva har vært motivasjonen bak inngåelse av PPAene?
    (a) Hvis vindkraftproduksjon: Er bilaterale avtaler knyttet til produksjon ved vindkraftanlegget(/ene)?
    (b) Hva var i så fall motivasjonen til å inngå en bilateral avtale knyttet til anlegget?
11. Hva er de viktigste argumentene for å foretrekke bilaterale avtaler fremfor finansielle kontrakter i de tilfellene dere har slike avtaler?

12. Hvilke avtalepunkter inneholder PPAene?
    (a) Leveranse 'as produced' eller baseload? Eller en annen fastsatt volumvariasjon?
    (b) Pris: Fast pris, indeksert pris, eller en årlig økende pris? Eller annet?
    (c) Er det nevnt noen tilleggsverdier i avtalene? F.eks. elsertifikater eller opprinnelsesgaranti?
13. Hvordan foregår prising av bilaterale avtaler hos dere?
    (a) Kan du beskrive prisingsmetoden?
    (b) Hvilket avkastningskrav brukes ved prising av kontraktene?
    (c) Hva bruker dere som prisprognose på fremtidig spotpris? (Egne og/eller Nasdaqs kurver for terminpris for å finne forventet spot?)
    (d) Risikopremie: Legger dere til noen form for risikopremie når dere priser bilaterale avtaler? (pga. en motpartsrisiko)
14. Hvordan vurderer dere motpartsrisiko knyttet til bilaterale avtaler?
    (a) Hvordan håndterer dere motpartsrisikoen?



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