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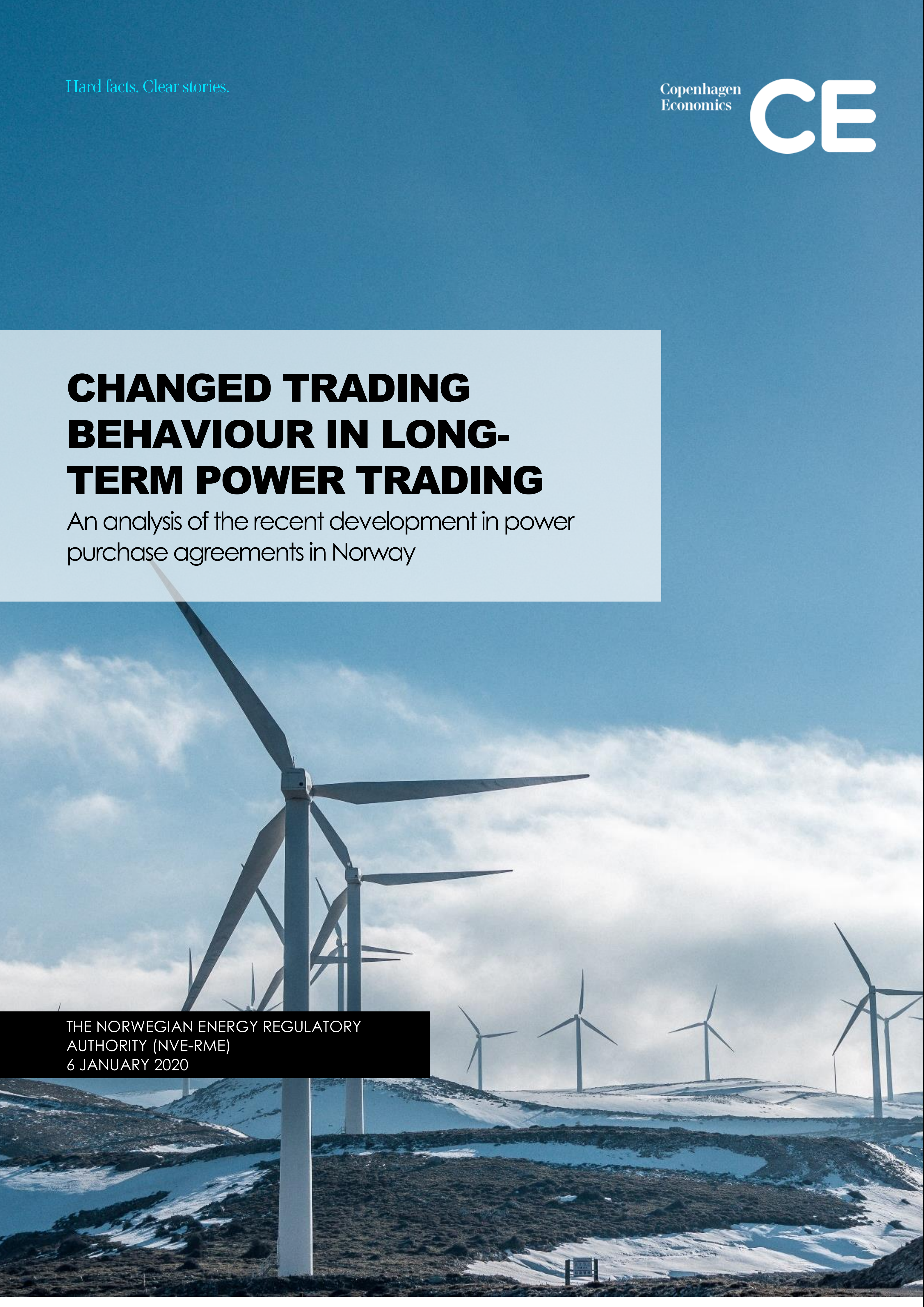

CHANGED TRADING BEHAVIOUR IN LONG-TERM POWER TRADING

An analysis of the recent development in power purchase agreements in Norway

THE NORWEGIAN ENERGY REGULATORY AUTHORITY (NVE-RME)
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PREFACE

In light of the increased focus on Power Purchase Agreements (PPA) in recent years, The Norwegian Energy Regulatory Authority (NVE-RME) wants to get a better understanding of the Norwegian PPA market. NVE-RME therefore asked Copenhagen Economics to conduct an analysis on the development and use of PPAs in Norway with a wider look towards Europe.

A key part of the task was to analyse how the market has developed and in particular getting an understanding of how the contractual elements are typically structured in the Norwegian PPA market. NVE-RME was also interested in how the use of PPAs affects different parts of the energy market, especially consequences for the financial forward markets.

The approach to this task was based on a mix between desk research of literature on PPAs, interviews with key market participants and industry knowledge in Copenhagen Economics.

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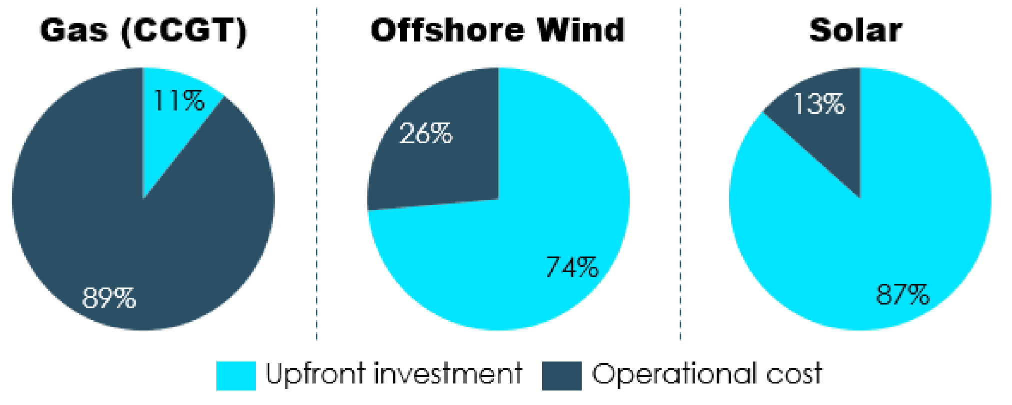
What are PPAs and how do they function?

The majority of power generated and consumed in Norway is traded at the power exchange Nord Pool. Typical options for hedging against price developments are available at Nasdaq OMX through financial market price contracts and EPADs.[1] Recently there has been a growing trend towards increased use of bilateral agreements, so-called Power Purchase Agreements (PPAs), both in the Nordics and in the rest of Europe.

A PPA is a direct bilateral agreement between a supplier and a consumer of power. Conducting bilateral power purchase agreements is not as such a new development. Traditional PPAs have been used by producers and consumers to trade electricity for many years. A development in recent years is the introduction of new types of buyers and sellers of PPAs in the market.

On the seller side, wind farms have dominated signings of new PPAs in recent years. This is driven by the large upfront investment resulting in lenders requiring developers' proof of a stable income stream, see Figure 1. On the buyer side, these new entrants are data centres and global corporates that are not only seeking hedging of prices but also proof of additionality with respect to renewable energy generation to underline their Environmental, Social and Governance (ESG) agenda.

Figure 1
Upfront investment as a share of total cost for different generation technologies



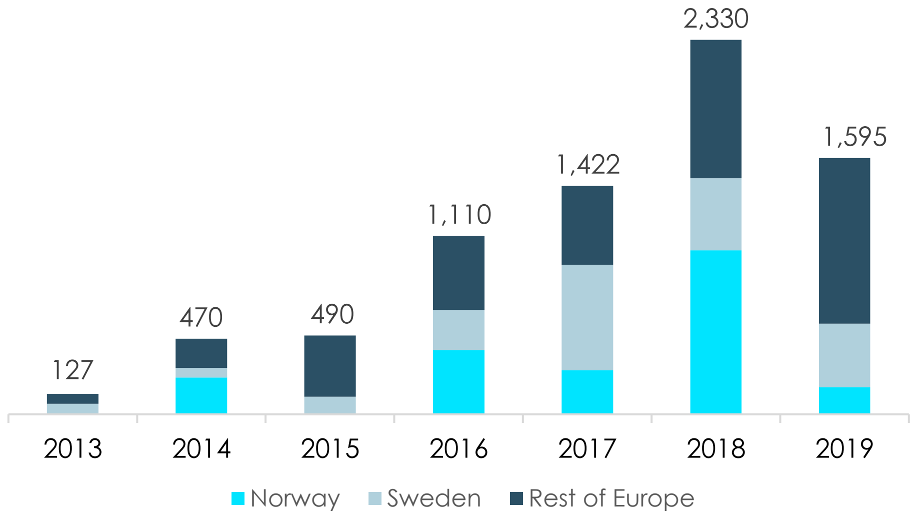
Note: Upfront investment consists of pre-development costs and construction costs. Operational cost consists of operation and management, fuel costs and carbon costs.
Source: BEIS (2016), Electricity Generation Cost, page 25.

[1] EPADS are Contracts for Difference between the system price and the resulting price in the different Nordic price areas.

The different market participants have widely different risk profiles motivating different PPA set-ups. The major differences between contracts are typically the duration of the contract and how the power is delivered (as produced or baseline). Other contractual elements are usually very similar. Most of the PPAs in Norway are physical contracts with a fixed price. Guarantees of Origin (GOs) are typically not included when the offtaker is heavy industry.

The number of announced new PPAs has increased in the Nordics and in particular Norway in recent years. Mostly, the announced PPAs are between a corporate consumer and a renewable producer. In Europe, announced new PPA signings have increased from around 127 MW in 2013 to 2.330 MW in 2018. Of these, Norway and Sweden have contributed with more than half of the PPA signings in the last five years, see Figure 4.

Figure 2
Signed PPAs in the Nordics and Europe (total capacity)
MW



Note: The list is not complete
Source: ICIS Power Perspective Outlook for corporate PPAs in the Nordic region

There are multiple drivers behind the increase in the use of PPAs. These include:

a) *Increasing data traffic which drives the construction of new data centres*. The expansion has led to large data centres being built around the world. In particular, the Nordics is a very attractive spot for new data centres due to the connectivity to the rest of Europe combined with the cool climate, leading to less requirement for cooling, and low power prices which provides an attractive business environment for energy-intensive industries. The data centres are being built for global tech companies such as Google and Facebook that are at the same time looking to be sustainable with respect to sourcing of energy.
b) *The expansion of wind and solar in the Nordics is driven by rapidly decreasing levelized cost of energy (LCOE) for wind and solar power as well as from moving away from fixed feed-in-tariffs to zero-subsidies*. Feed-in tariffs are on the way out and lenders are requiring developers to find other stable income streams. Other subsidy schemes such as

Elcertificates have supported the PPA market. At the same time, the LCOE of wind and solar technologies are on the level of a competitive power price (disregarding balancing costs).

c) *Increased focus on Environmental, Social and Governance (ESG) and in particular additionality of renewable energy consumption*. Consumers need to ensure that they are reducing their emissions, and a clear way to show this is to sign a PPA deal. Signing a PPA allows for a more direct claim on renewables which in some instances is additional (in particular if it is signed before the developer's investment decision)

What makes a PPA different from financial market products?

An alternative approach to hedging long-term price risk is to use the financial future markets. Financial futures are power contracts traded on an exchange such as the Nasdaq OMX and can be traded up to 10 years ahead. The future market is purely a hedging product as no other products or services are attached. The products traded on the financial forward markets therefore have no physical power associated and can be very similar to financial PPAs.

We find that there are three key differences that drive the market participants' choice of entering into a PPA or a financial future:

- *Firstly*, the PPAs can be tailored to suit the specific circumstances of the participants in the agreement. This allows for better management of volume risk, bundling with GOs, balancing etc. The flip side of this possibility is that it also increases the complexity of the hedging and increases costs of negotiations. Comparatively, the financial market has standard terms removing negotiation costs.
- *Secondly*, counterparty risk[2] can be a potential major hidden cost in PPAs and must be considered carefully.[3] The regulation in the financial markets reduces counterparty risk significantly. While different guarantee and collateral setups do exist for PPAs, it is a requirement in every transaction on the future market to provide collateral which can cover default by any participant.
- *Thirdly*, regulatory barriers in the financial market seem to favour signing of physical PPAs. Financial regulation such as MIFID II[4] and accounting standards (IFRS) add additional costs of entering into purely financial products (including financial PPAs). There are no indications of regulatory barriers to the PPA market in Norway, but there are several at the EU-level which may also be relevant in Norway, see Figure 3.

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[2] Counterparty risk is the risk the other party in the contract is unable to fulfil their contractual obligations.

[3] https://energiwatch.dk/secure/Energinyt/Renewables/article11751401.ece

[4] Directive 2014/65/EU on MiFID II and Regulation (EU) No 600/2014 on markets in financial instruments

Figure 3
Regulatory barriers to PPAs at the EU-level

Unequal treatment across borders	• Differences in whether market designs ensure compensation for renewable energy curtailments • Consuming power through PPAs means that companies can become ineligible for indirect carbon cost compensation • Restrictions on e.g. third party ownership, number of buyers per installation and number of suppliers per metering point • Differences in tax regimes and legal systems
Guarantees of origin (GOs)	• GOs system currently does not ensure transparent and traceable green electricity. Risk of double counting. • Some countries do not allow issuance of GOs if RE-facilities receive government support – even if only a minor share

Source: Copenhagen Economics (2019), Google's hyperscale data centres and infrastructure ecosystem in Europe, page 63

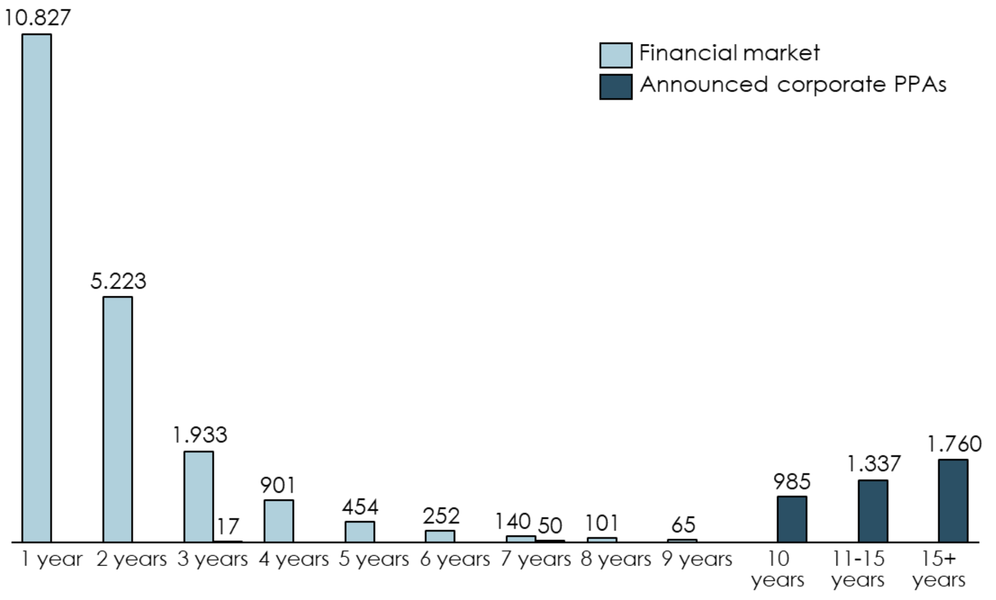
Possible impact on the hedging opportunities from the development of PPAs
Sufficient hedging opportunities in the energy markets is an important goal for the European Commission. The Forward Capacity Allocation (FCA) guidelines stipulate that the forward markets should provide sufficient hedging opportunities for market participants across bidding zones. If the hedging opportunities turns out not to be efficient, according to evaluation criteria set out in the FCA guidelines, long-term transmission rights must be introduced, or other measures must be implemented to ensure the efficiency of long-term hedging opportunities.

In Norway, the forward market and the PPA market are both providing hedging opportunities to the market participants. Compared to other countries, the PPA market in Norway is relatively large due to the larger importance of the energy intensive industry.

The financial future market is primarily used for shorter term hedges up to five years, whereas the PPA market is used for longer term hedges. This is evident when looking at the open interest (or total size of active contracts) which is decreasing over time for the financial market and increasing for PPAs. The size of active announced corporate PPA contracts agreed 10 years ahead is 985 MW, in comparison there were a similar amount (901 MW) open interest for a future 4 years ahead, see Figure 4.[5] As a consequence, we also see the new PPA contracts as filling out new needs in the market, complementing hedging opportunities, as opposed to measures that undermine the existing more short to medium term financial contracts.

5 Here the open interest on the financial market covers a specific year, while the PPAs cover every year 10 years ahead.

Figure 4
Open interest for Nordic financial market and PPAs split on deal horizon
MW



Note: Financial futures cover only a single year, while PPAs cover the entire period. PPA volume shown includes 27 announced corporate PPAs which are still active today. Financial futures only offered up to 10 years ahead. Open interest is only shown for annual future contracts. "Financial market" include open interest for system future and system deferred settlement futures. Open interest as of 23 December 2019.

Source: Copenhagen Economics based on data from Nasdaq Commodities and press releases from 2013-2019.

CHAPTER 1

WHAT ARE PPAS AND HOW DO THEY WORK?

In this chapter, we will explain what a PPA is and why it is used by market participants on the Nordic power market. We will firstly describe the different types of PPAs existing today (1.1). Secondly, we will describe the risk exposure of different types of market participants (1.2) and the different structures and uses of PPAs (1.3). Lastly, we will describe the recent development in interest for PPAs in the Nordics and Europe and explain some of the drivers behind this increase in interest (1.4).

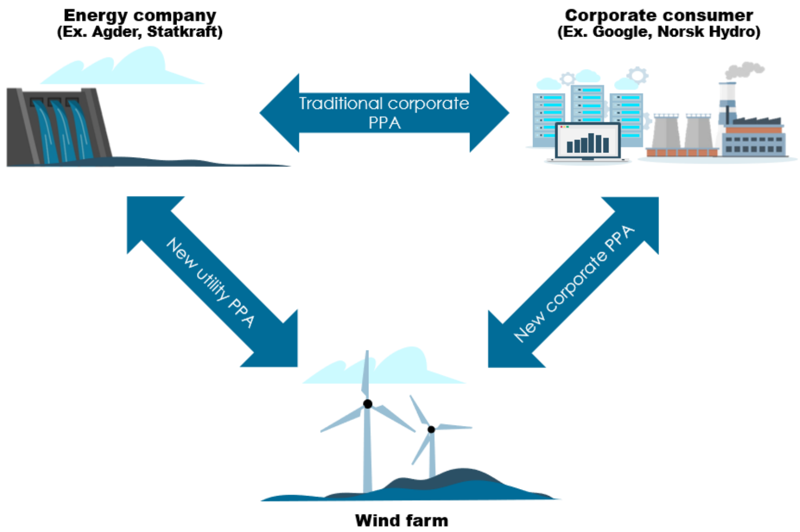
1.1 THE DIFFERENT TYPES OF PPAS

A Power Purchase Agreement (PPA) is a bilateral contract for trading of power between a producer and an offtaker. While most power trading in the Nordics is done on a market exchange 24 hours before it is used, a PPA will often be agreed on several years ahead.

The use of PPAs has become increasingly popular in recent years, and new variations of PPAs have emerged. Traditional corporate PPAs are a bilateral agreement on a power price between a producer of power and a corporate consumer of power cf. Figure 5. While PPAs have existed for many years, new types of consumers and producers are emerging creating innovative solutions in both structure and usage. New models for agreements can be split into two categories: 1) New corporate PPAs which are between a corporate consumer and a developer of a specific wind farm.[6] 2) Utility PPAs which involve selling power to a utility or an energy company instead of directly to the consumer. While there are different general characteristics between corporate and utility PPAs, the contracts can be very similar. Therefore, we will, in this report, not make a general distinction between corporate and utility PPAs.

[6] The same setup is also used for solar farms and other renewables.

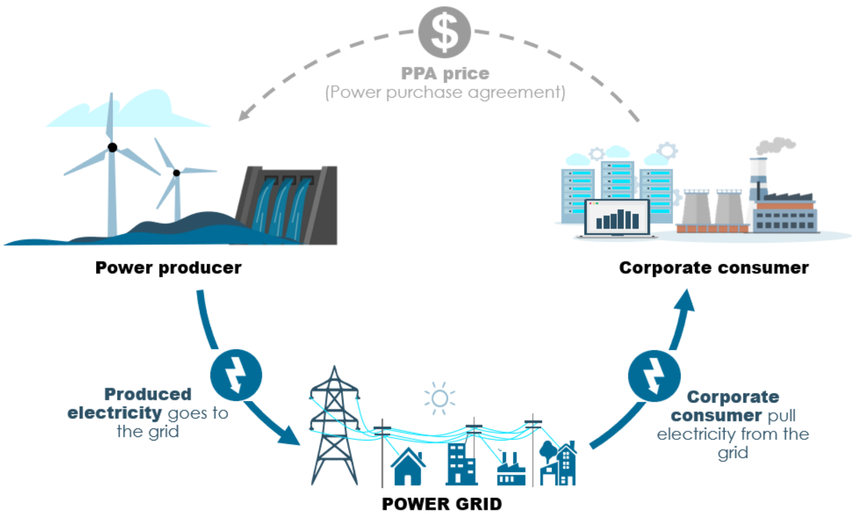
Figure 5
Comparison between a traditional PPA and new types of PPAs



Source: Illustration by Copenhagen Economics

In the Nordics, the power associated with a PPA is transferred through the power grid as any other power. The power traded through the PPA is registered as a trade on the market exchange to allow for the market clearing and balancing. Depending on the structure of the PPA, the one responsible for ensuring sufficient power delivered will buy additional power on the exchange and vice versa for the consumed power, see Figure 6.

Figure 6
Illustration of the functioning of PPAs in the power market



Note: Grid connection between producer and consumer is not a necessary condition for entering into a PPA.
Source: Illustration by Copenhagen Economics based on Copenhagen Economics (2019), Google's hyperscale data centres and infrastructure ecosystem in Europe, page 58

1.2 RISK EXPOSURES OF MARKET PARTICIPANTS IN THE ELECTRICITY MARKETS

PPAs are a flexible approach to handling a variety of long-term risks for both producers and consumers. The risk exposures for the different market participants are highly dependent on the business model of the participants. The major determining factors are the degree of capital investments, consumer market competition and planning horizon. While the producers' risk setup creates a natural supply of PPAs, the consumer side varies more.

Based on differences in the risks faced, market participants can be split into two types of producers and three types of consumers:

Producers

- *Traditional power producers* like hydro plants
- *New renewable energy developers* of solar and wind power

Consumers

- *Heavy industry* including aluminium, FeSi and steel.
- *Other energy-intensive consumers* like retail companies
- *New buyers* mainly consisting of data centres

Producers

Traditional power producers have large investments tied to power plants. For large hydro power plants, which are dominant in Norway, the lifetime of the investments is between 40-80 years.[7] Making an investment of this size for such a long period carries a risk of potential stranded assets if, for example, new technologies are able to underbid in the market. Owners of these plants are therefore willing to accept a lower price for their power compared to the expected spot price in order to ensure a certain return on their investment. Many of the hydropower plants in Norway were, however, built between 1950-1990 and many are probably payed off.[8]

New renewable energy developers share some of the same risks as the traditional power producers but are exposed to additional risks related to the actual production. Wind and solar farms typically want to hedge the life time of the wind turbine which historically have been between 10-25 years.[9] The majority of these deals have a duration between 10-15 years with the longest being 29 years.[10] Due to the large upfront investment carrying the majority of the costs of producing wind or solar, banks and other lenders require certainty in the income stream in order to issue a loan. Around 75% of the cost of producing wind is upfront, compared to 11% for a gas plant, see Figure 7. Before the project can be approved, the wind developer will need to present a signed PPA or another proof of a certain revenue stream. On top of the issue of very large upfront investment, wind and solar require some balancing due to the unpredictable nature of their generation. Their risk is price

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7 IRENA (2012), Renewable Energy Technologies: Cost Analysis Series: Hydropower, page 20

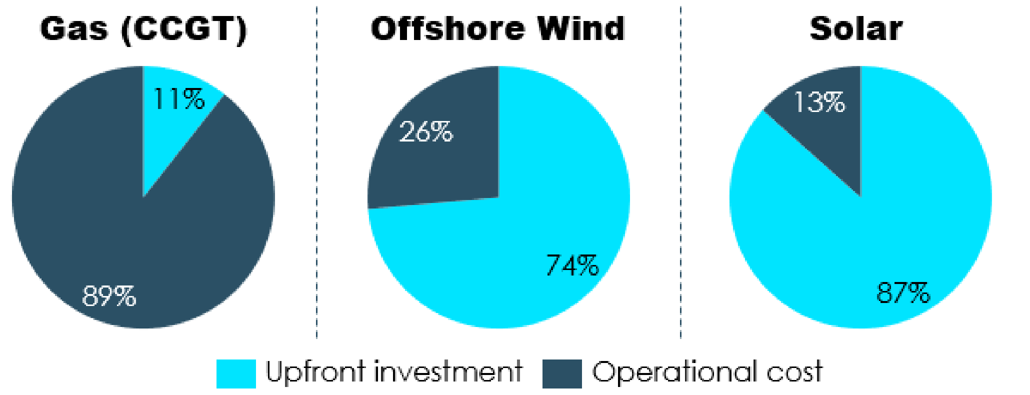
8 NVE Vannkraftdatabase, www.nve.no/energiforsyning/vannkraft/vannkraftdatabase, retrieved December 4, 2019.

9 Megavind (2016), Strategy for Extending the Useful Lifetime of a Wind Turbine, page 10

10 Norsk Hydro and GIG/SCA Energy signed in 2018 a 29-year long deal for the Överturingen wind farm. This deal also includes a 25-year operations and management deal with Siemens ensuring the maintenance of the wind farm. https://greeninvestmentgroup.com/news-and-insights/2018/green-investment-group-reaches-financial-close-on-new-235mw-ppa-backed-onshore-wind-farm/

cannibalisation if too much wind and solar is introduced into the same area. This is a situation where prices are very low when these sources produce since they will usually produce at the same time. Price cannibalism will lower the revenue of all wind or solar power in the area. However, it is less of an issue in Norway due to the abundant amount of hydropower.

Figure 7
Upfront investment as a share of total cost for different generation technologies



Note: Upfront investment consists of pre-development costs and construction costs. Operational cost consists of O&M, fuel costs and carbon costs.
Source: BEIS (2016), Electricity Generation Cost, page 25.

Consumers
Buyers of the more traditional PPAs, such as the aluminium sector, are exposed to a very competitive consumer market. In the aluminium sector, electricity costs constitute around 30-40% of the total production costs, so even a small increase in power price can potentially have a big impact on the competitiveness of the specific smelter.[11] This incentivises long PPAs. In the Nordics, some of the longer deals include Norsk Hydro's 29-year PPA from Övertungen in Sweden and Alcoa's 40-year PPA with Landsvirkjun in Iceland.[12]

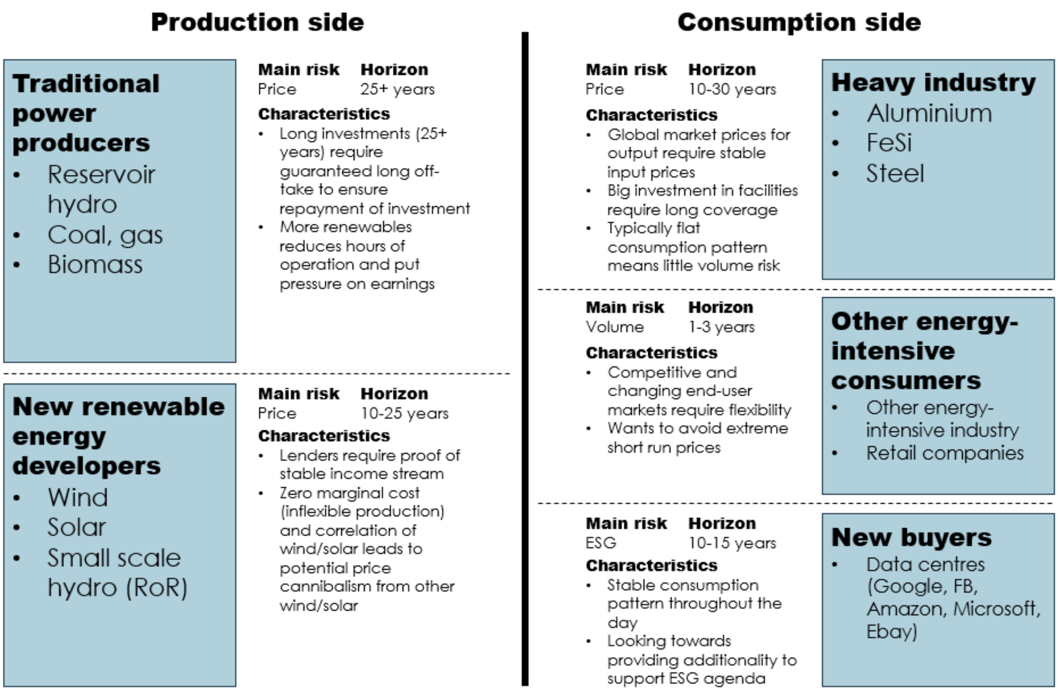
Other energy-intensive consumers have a very different risk profile. Some consumers operate with shorter planning horizons to stay flexible in response to the market dynamics. These companies are more exposed to volume risk and short-term price risk as opposed to long-term price risk. An example is Tetra Pak, who operates with a three-year planning horizon.[13] Another example is retail companies who are buying wholesale power and reselling to consumers and businesses. Most end-user contracts can be cancelled with a few months' notice, meaning their end-user demand can be unpredictable looking years ahead.

New buyers of PPAs are big global companies who have different agendas. In the Nordics, this has primarily been Google and Facebook looking to source power to their data centres. However, other examples of new types of buyers include the pharmaceutical/biotech companies Novo Nordisk and

[11] EC Group (2016), Methods for evaluation of the Nordic forward market for electricity, page 24
[12] https://askjaenergy.com/2017/05/20/alcoas-tariff-in-iceland-renegotiated-before-2028/
[13] https://winddenmark.dk/nyheder/tre-tiltag-flere-ppaer

Novozymes in Denmark.[14] While they do care about the long-term power price, the competitiveness of these companies is driven by different factors. These companies are more exposed to potential "softer" risk elements such as a public backlash from a lack of action on their Environmental, Social and Governance (ESG) agenda. PPAs enable them to show additionality on top of a stable power price to match their consumption.

Figure 8
Generalized characteristics of market participants in the power market



Note: These are simplified characteristics for producer and consumer groupings. None of the characteristics are based on any individual company. Each market participant may have different characteristics or risks.
Source: Copenhagen Economics

1.3 THE STRUCTURE AND USE OF PPAS IN THE NORDICS

The risks faced by market participants motivate different contractual arrangements in PPAs. The flexibility of a PPA allows for a tailor fit of risk management to each party. Typical contractual elements include the specification of:

[14] https://group.vattenfall.com/press-and-media/news--press-releases/pressreleases/2018/vattenfall-novozymes-and-novo-nordisk-sign-a-long-term-power-purchase-agreement-from-denmarks-largest-offshore-wind-park-kriegers-flak

a) Physical or financial agreement
b) Price
c) Duration
d) Profile of volume
e) Balancing responsibility
f) Energy Attribute Certificate (EAC) ownership

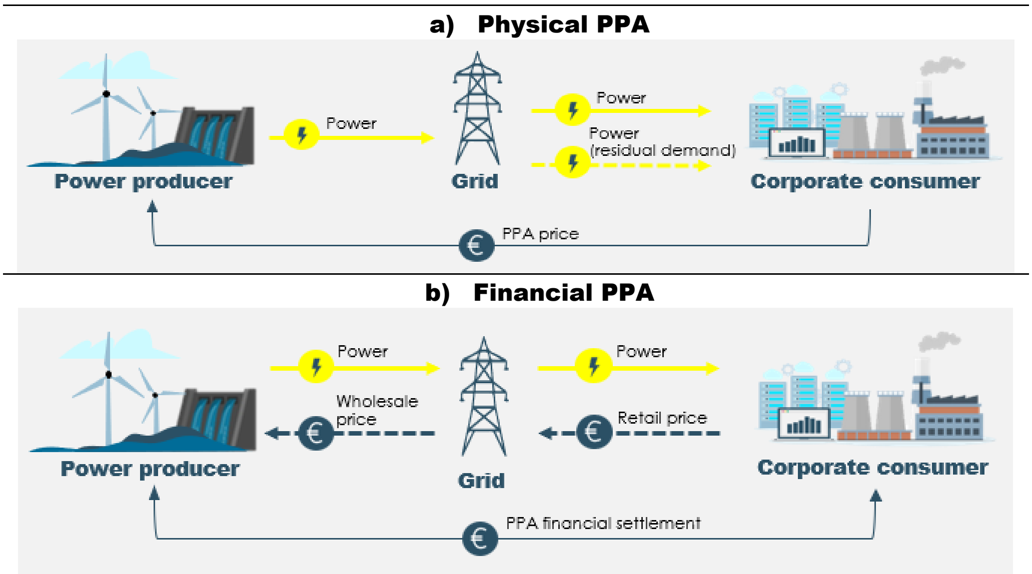
a) Physical or financial agreement

PPAs can generally be split into whether the agreement is physical or financial.

Physical PPAs are agreements on delivery of a certain volume of electricity at a specified price.[15] A power producer will feed its production into the grid while the corporate consumer will cover its consumption through the grid, see Figure 3. Contracts with a physical element are the most common in the Nordics.

Financial PPAs are agreements which are purely financial without a physical flow of power, as shown in Figure 3.[16] These agreements are so-called Contracts for differences (CfD) to the market price. The practical implication is the same as a physical contract except that the two parties must buy and sell power through the market. They will then settle any difference from the market price to the agreed CfD-price. The financial PPAs are not very common in the Nordics, but they do exist.

Figure 9
Structure of physical and financial PPAs



Source: Illustration by Copenhagen Economics based on RE-Source (2019), Introduction to Corporate Sourcing of Renewable Electricity in Europe p. 34 and 38

[15] Physical PPAs are also known as "sleeved" PPAs.
[16] Financial PPAs are also known as "synthetic" or "virtual" PPAs.

b) Price

Most PPA contracts fix the price through an agreed period, but it may change according to agreed terms. Fixing the price provides certainty of the future power price for both parties which ensures a stable revenue stream for the producer and no unexpected changes in the electricity costs for the consumer.

The price on the financial future market typically serves as a starting point of price negotiations together with price forecasts by different providers. While a future for 10 years ahead is a market price for hedging 10 years ahead, it is not the expected spot price 10 years ahead. Due to an oversupply of producers willing to sell long PPAs, the future price 10 years ahead will carry a negative risk premium meaning that the agreed PPA price will be below the expected spot price. In addition to this, specific contractual elements such as delivery terms, EACs and guarantee elements also impact the price.

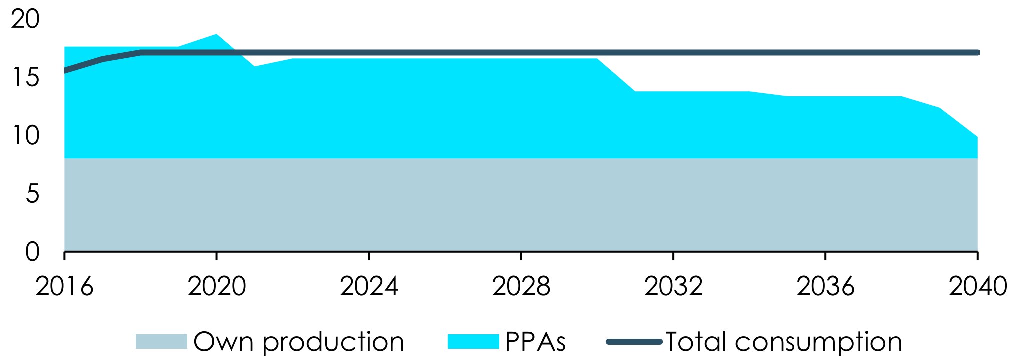
Some longer contracts feature a possibility for price negotiations or rebalancing after a certain period and may be linked to consumer market price, e.g. the aluminium price.

c) Duration

The duration of a PPA is dependent on the planning horizon and risk aversion of the buyer and seller. Producers typically want to match the tenor (duration) of their debt, while consumers typically want to hedge shorter in order to balance the price and volume risk. Fossil fuel-based producers are also exposed to operational cost risks from the development of coal and gas prices and will need to hedge the coal or gas price if they were to sign a long-term PPA. Coal and gas plants are, to our knowledge, not directly associated with PPAs in the Nordics but may be part of a "mixed portfolio" product.

Like producers, some heavy industry consumers are exposed to large capital investments which incentivises them to typically hedge longer (15+ years). As an example, the aluminium producer Norsk Hydro have hedged their entire expected consumption in Norway for the next 15 years and about 80% of the expected consumption between 15-25 years, see Figure 10.

Figure 10
Electricity sourced by Norsk Hydro
TWh



Source: Copenhagen Economics based on Norsk Hydro (2019), Third quarter 2019 Investor presentation, page 81 *d) Profile of volume*

The power delivered in a PPA is typically either delivered "as produced" or as baseload. For either option, someone needs to match generation with consumption either through the market or by controlling production or consumption. This responsibility can be given to the producer, consumer or a contracted third party.

"As produced" is common for wind and solar farms and is most attractive to developers of these type of projects since it removes some of their risk. If this power is to be purchased by the consumer, it needs a third party with sufficient flexible generation sources, such as hydropower, which can be used to match the demand. The market for utility PPAs is largely driven by the need of the developer to remove some of their production risk. This risk is then acquired by utilities with larger portfolios who can shape the power into baseload.

Some larger energy producers or consumers take on the balancing and shaping responsibility themselves. Typically, they will have a department working full-time with balancing or hold the necessary assets to ensure the preferred shaping. For smaller producers or consumers, it is more often preferred to designate a third party that provides shaping services for a fee as part of their business. In practice, shaping is often done by the shaping party by optimising the production and consumption side separately and trading residual production and consumption with the market exchange.

e) Balancing responsibilities

Balancing responsibility towards the TSO can appear on both the producer and consumer side of the grid connection. The balancing responsibility often lies with the consumer who is responsible for balancing their consumption in relation to the baseload purchase. In practice, this is often done by a third party for a fee.

The balancing responsibility becomes even more important in cross price zone PPAs. In these cases, producers or third parties with a large production portfolio in both price zones are useful. The producer or third party will turn up production in one price zone and down in another to ensure balancing. This will make it more cost-effective to be the balancing responsible.

f) Energy Attribute Certificate (EAC) ownership

For PPAs related to renewable power production, there can be a specification of whether so-called EACs are also included in the trade. The idea of EACs is to provide a proof of where the consumed electricity is produced which will then provide renewable energy producers with a higher price on their power. In Norway, there are two different types of EACs. These are Elcertificates (el-cert) and Guarantees of Origin (GOs). El-certs are only issued in Norway and Sweden while GOs are a pan-European system. The el-certs are typically handled by the producers, while the GOs are sold to consumers.[17]

GOs are an extra source of income for the producers of renewable energy sources, which in Norway is almost all of the production. The income from GOs constitute about 1% of the wholesale power price.[18] While GOs are generally part of many PPAs, some of the big buyers of PPAs in Norway do not want GOs included in their PPAs. These big buyers do not want to legitimise GOs by including

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17 https://www.statnett.no/en/for-stakeholders-in-the-power-industry/system-operation/the-power-market/elcertificates-and-guarantees-of-origin/

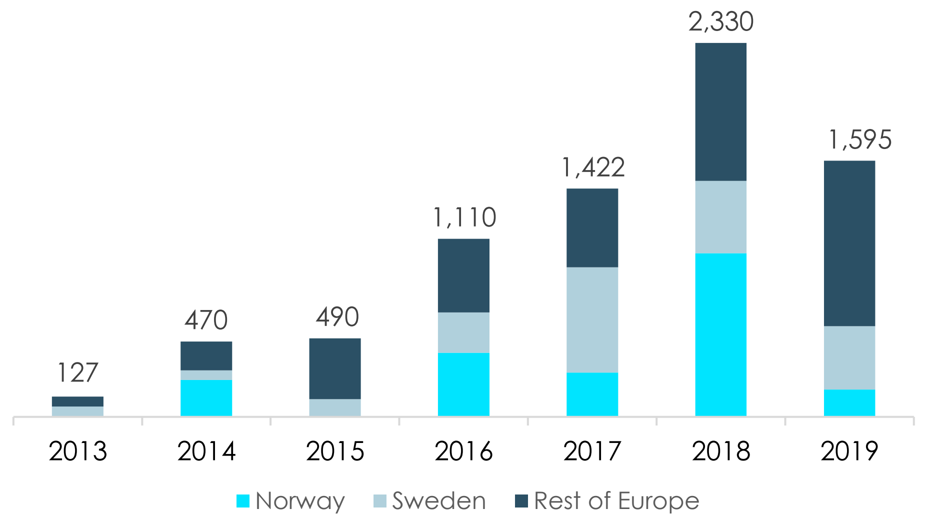
18 Oslo Economics (2017), Analysis of the trade in Guarantees of Origin, page 19

them in PPAs. These buyers argue that the GOs do not constitute a proof of additionality and that they allow consumers across EU member states to call themselves green for a very low price despite using non-renewable energy in their production. GOs has been criticised as a tool for greenwashing due to the potential double compensation when combined with other renewable subsidies which is why some offtakers do not include it in their PPAs.[19]

1.4 PPAS HAVE IN RECENT YEARS GROWN IN IMPORTANCE

The number of announced new PPAs has increased in the Nordics and in particular Norway in recent years. Mostly, the announced PPAs are new corporate PPAs with a renewable producer. In Europe the announced new PPA signings have increased from around 127 MW in 2013 to 2.330 MW in 2018. Of these, Norway and Sweden have contributed with more than half of the PPA signings the last five years, see Figure 4. However, it is important to note that not all deals are announced to the public, and the actual number of PPA signings is therefore be larger than displayed here.

Figure 11
Signed PPAs in the Nordics and Europe (total capacity)
MW

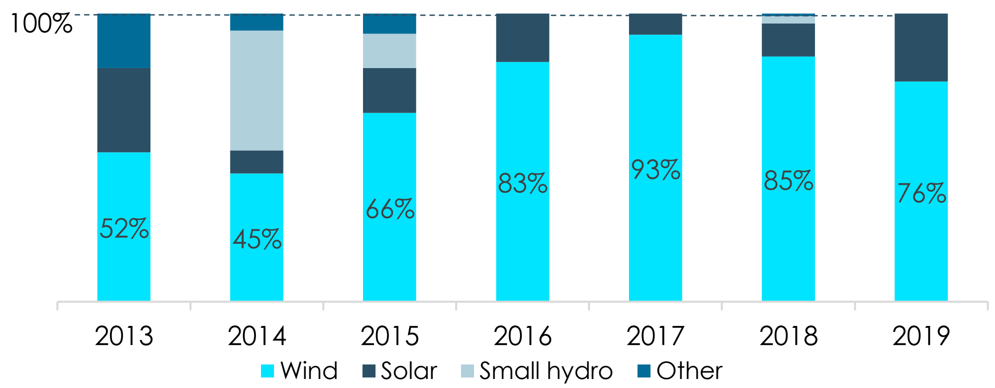


Note: The list is not complete
Source: ICIS Power Perspective Outlook for corporate PPAs in the Nordic region

The increase in PPA capacity is widely driven by wind PPAs. Since 2016, wind has constituted more than 75% of the new PPA signings every year, see Figure 3. Likewise, solar has also become more popular in PPAs. The increasing use of wind and solar is one sign that the PPAs are being used as a risk mitigation tool by developers, lowering project risks and enabling bigger expansion of wind and solar.

[19] Bloomberg New Energy Finance (2018), What Drives Europe's Top Three Corporate PPA Markets?, page 6

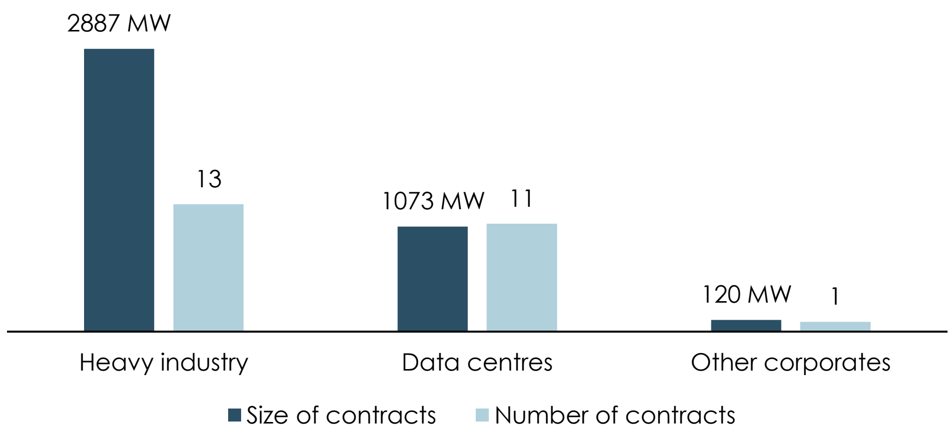
Figure 12
PPA capacity in the EU by estimated signing year, broken down by generation source
Pct.



Source: Bloomberg New Energy Finance 2019

On the consumer side, data centres are a major driver for the new demand, driving almost 1100 MW PPAs in the last three years. The PPA market in the Nordics is however still dominated by heavy industry with almost 2.900 MW announced corporate PPAs. However, the number of contracts is about the same with 11 for data centres and 13 for heavy industry, indicating that the average contracts are larger for heavy industry than for data centres, see Figure 13.

Figure 13
Offtakers of corporate PPAs in the Nordics (2013-2019)



Note: Includes announced PPAs from 2013 – 2019. Only includes PPAs with a corporate consumer as offtaker. "Other corporates" include one contract from Denmark where Novo Nordisk and Novozymes together were offtakers.
Source: Copenhagen Economics based on 25 press releases

There are multiple drivers behind this increase in announced PPAs. Below are some of the major drivers of new PPAs in the Nordics.

1) Increase in data traffic drives construction of new data centres
2) Decrease in levelised cost of energy (LCOE) combined with reductions in some subsidy schemes for wind and solar drives expansion of commercially viable projects
3) Increased focus on Environmental, Social and Governance (ESG) and in particular additionality of renewable energy consumption

1) Increase in data traffic drives construction of new data centres

Increased data traffic requires more and larger data centres to handle the data. The expansion has led to large data centres being built around the world. In particular, the Nordics is a very attractive spot for new data centres due to the connectivity to the rest of Europe combined with the cool climate, leading to less requirement for cooling, and low power prices which provides an attractive business environment for energy-intensive industries. The data centres are being built for global tech companies such as Google and Facebook who at the same time are looking to sourcing sustainable energy. While there is a trend of rapidly increasing magnitude of data centre traffic, it is uncertain whether the overall energy demand will follow suit due to improvements in energy efficiency in data handling and an increase in the use of the more energy efficient hyperscale data centres.[20]

2) Decrease in LCOE together with reductions in some subsidy schemes for wind and solar drives expansion of commercially viable wind and solar projects

The expansion of wind and solar in the Nordics is driven by rapidly decreasing LCOEs for wind and solar power as well as from moving away from fixed feed-in-tariffs to zero-subsidies. Feed-in tariffs are on the way out and lenders are requiring developers to find alternative ways to ensure a stable income stream. Other subsidy schemes such as el-certs have supported the PPA market.

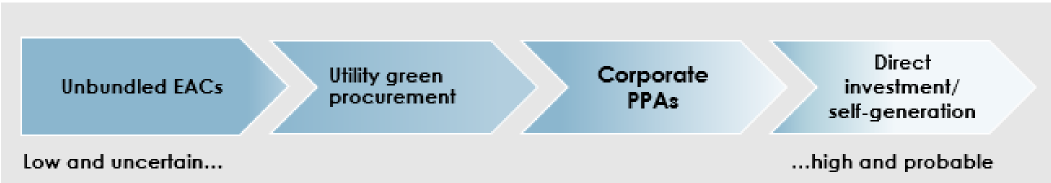
The LCOE of wind and solar technologies are on the level of a competitive power price (disregarding balancing costs). Many of the constructions of new wind and solar farms are driven by developers as opposed to utilities. PPAs are crucial for developers in order to gain access to financing from banks. Banks will require a steady income stream many years ahead to ensure sufficient liquidity and the only way to achieve this is to have a either a utility or corporate PPA to offtake the volumes.

[20] https://www.iea.org/tcep/buildings/datacentres/

3) Increased focus on Environmental, Social and Governance (ESG) and in particular additionality of renewable energy consumption

ESG of corporate consumers is a large driver for the PPA market. Consumers need to ensure that they are focusing on reducing their emissions, and a clear way to communicate this is to sign a PPA deal. Signing a PPA allows for a more direct claim on renewables which in some instances is additional (particularly if it is before the investment decision), see Figure 5. There is a specific drive from global companies such as Google and Facebook who also use the projects to provide a clearer story of their green energy sourcing. Tying it to a specific project is much easier to communicate than when purchasing green power from a mix of projects.

Figure 14
Additionality of different renewable energy sourcing methods



Source: *IRENA (2018), Corporate Sourcing of Renewables: Market and Industry Trends, page 60*

CHAPTER 2

WHAT MAKES A PPA DIFFERENT FROM FINANCIAL MARKET PRODUCTS?

In this chapter, we compare PPAs to the more standardised financial market products for power price hedging. In the first section, we describe the differences between these two options in order to explore why different offtakers might choose each of these (2.1). In the second section, we look into the possible impact on hedging opportunities from the development of PPAs (2.2).

2.1 PPAS AND FUTURE MARKETS CATER TO DIFFERENT HEDGING NEEDS

An alternative approach to hedging long-term price risk is to use the financial future markets. Financial futures are power contracts traded on an exchange such as the Nasdaq OMX and can be traded up to 10 years ahead. The future market is purely a hedging product as no other products or services are attached. The products traded on the financial forward markets therefore have no physical power associated and can be very similar to financial PPAs.

A future product covers only a specified period, e.g. a specific year[21], therefore in order to provide a similar product as, e.g. a 10 year PPA, it is necessary to purchase 10 annual futures: one for year 2020, one for 2021 and so on.[22] The products traded on the future market are based on the Nordic System Price, which is the theoretical Nordic power price in a given hour if there were no transmission constraints in the grid. In order to hedge price differences in specific bidding zones, providers can buy so-called Electricity Price Area Differentials (EPAD), which hedges the difference between the system price and the price in specific bidding zones.[23]

We find that there are three key differences which drive the market participants' choice of entering into a PPA or a financial future:

- *Firstly*, the PPAs can be tailored to suit the specific circumstances of the participants in the agreement. This allows for better management of volume risk, bundling with GOs, balancing etc. The flip side of this possibility is that it also increases the complexity of the hedging and in particular increases the negotiations costs. Comparatively, the financial market has standard terms removing costs of negotiations.
- *Secondly*, counterparty risk[24] can be a potential major hidden cost in PPAs and must be considered carefully.[25] The regulation in the financial markets reduces the counterparty risk significantly. While different guarantee and collateral setups do exist for PPAs, it is a requirement in every transaction on the future market to provide collateral which can cover default by any participant.
- *Thirdly*, regulatory barriers in the financial market seem to favour making physical PPAs. Financial regulation such as MIFID II[26] and accounting standards (IFRS) add additional

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21 It is also possible to trade, quarterly, monthly, weekly and daily future for a shorter horizon.

22 It is possible to trade a so-called strip which clear trades in multiple years at the same time.

23 Alternatively, the market participants can purchase transmission rights on cables to outside of the Nordics e.g. Denmark-Germany together with a future on the German market.

24 Counterparty risk is the risk the other party in the contract is unable to fulfil their contractual obligations.

25 https://energiwatch.dk/secure/Energinyt/Renewables/article11751401.ece

26 Directive 2014/65/EU on MiFID II and Regulation (EU) No 600/2014 on markets in financial instruments

costs on entering into purely financial products (including financial PPAs). Meanwhile, there are few if any regulatory barriers to physical PPAs in Norway.

1) Options to reduce high compliance costs in PPAs

While the flexibility of a PPA is advantageous for the signing parties, it also entails large costs of negotiations. Allowing for large flexibility in contracts means that many contractual elements needs to be negotiated and agreed upon. Furthermore, as risks and needs of either party varies, contractual elements must be negotiated from scratch. Negotiations on these contractual elements is costly in terms of both time and fees for advisors.

The high share of administration costs makes smaller PPAs too costly compared to their benefits. Contractual elements needing to be negotiated in a PPA are the same independently of the size of the PPA.[27] Costs of negotiating a PPA therefore do not scale with the contract size. In a smaller size PPA these costs will more likely outweigh the benefits. Of announced PPAs in the Nordic in recent years, some of the smallest are around 40-50 MW. According to some stakeholders, the practical minimum size of PPAs is around 10 MWs.[28]

Efforts are being made to standardise PPA contracts. One such example is the RE-source initiative which has recently published a standardised template for PPAs.[29] While this may reduce the entry barrier for some market participants, it will only provide a starting point for negotiations. The template could provide an overview of the necessary contractual elements for less experienced parties that are interested in entering into the PPA market. However, a major share of the costs of signing a PPA is still related to negotiations.

Another potential for lowering the cost barrier is the development of PPA syndicates. Smaller producers or offtakers can usually not produce or offtake large enough quantities for a PPA to be beneficial. However, a group of smaller producers or offtakers can form a syndicate to reach the necessary size for a PPA to make financial sense. A syndicate may also improve the bargaining position when negotiating. However, there are only few examples of syndicates in the Nordics. One example is the Fosen wind project which makes up a developer syndicate.[30]

2) Dealing with additional counterparty risk in PPAs

Strong counterparty exposure in PPAs requires substantial due diligence. From the developer's perspective, there is a risk that the offtaker will default before the PPA is concluded and leave the developer without the guaranteed revenue stream. Likewise, there is a risk for the offtaker that the developer defaults and the offtaker will be left with the only option of trading in the wholesale market. Aside from the direct risk related to the price, a default of one party may reduce the credit worthiness of the other party. While most PPAs are signed with large corporations with high credit ratings, this will not eliminate the risk completely.

Some PPAs feature a guarantee construction to cover the default risk. This typically involves the global parent company issuing a guarantee for their subsidiary signing the PPA. In case their local subsidiary defaults or for other reasons are not able to fulfil their contractual obligations, the parent

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27 Offtakers can have multiple PPAs with same supplier (e.g. new power demand arising from capacity expansion) – contractual terms may be reused, which reduces overall costs of entering into subsequent deals with the same supplier.

28 Based on interviews with relevant market participants.

29 https://efet.org/standardisation/cppa/?ref=re-source

30 https://www.power-technology.com/projects/fosen-vind-power-project/

company will step in. Other types of guarantees include a third-party guarantee from, e.g., a financial institution which essentially functions as an insurance. Such guarantees are rare, but an example is the Norwegian Guarantee Institute for Export Credits (GIEK) who can provide guarantees to energy suppliers in case of buyer's non-fulfilment of a power contract.[31]

Financial markets are subject to stricter regulation requiring collateral to cover in case of default of any market participant. The European Market Infrastructure Regulation (EMIR) was introduced to mitigate credit risks of trading parties for financial derivatives. All trading of these products must be conducted through an exchange or else risk mitigation techniques must be applied. These exchanges must comply with stringent prudential, organisational and conduct of business requirements. As an example, trades on Nasdaq are covered by a fund which covers default by any participant. Trading through an exchange as Nasdaq is therefore removing a major part of the counterparty risk.

3) Fewer regulatory barriers to PPAs

Market participants in Norway do not see any significant regulatory barriers when signing PPAs. However, previous studies have registered several regulatory barriers at the EU-level that restricts further spreading of PPAs. These barriers can be grouped into issues that are handled differently across member states and problems with the GOs-system. An overview these barriers can be found in Figure 15.

Curtailment of renewable energy can be necessary in many countries due to grid capacity limits. However, in some member states it is not clear whether there will be given compensation for reducing the production of a power producer.[32] This is a challenge for, e.g., wind and solar producers looking to sign a deal for delivery of electricity.

Another barrier is the risk of losing compensation from increased indirect carbon cost when entering into a renewable energy PPA.[33] EU member states can grant compensation for the increased power price due to a higher ETS price. However, in some member states electricity through a renewable energy PPA is thought to be unaffected by the ETS price. Signing such a PPA is therefore at the risk of losing compensation.

Other barriers have also been documented in individual member states. These are related to the number of buyers per installation and the number of suppliers per metering point which makes PPA syndicates more complex.[34] Likewise, more traditional barriers related to different tax regimes and legal systems can also be an issue when engaging in a PPA.

There are also limitations in the current GOs-system. As GOs have been implemented unevenly in the EU, there is a risk of double counting due to different tracking systems.[35] Furthermore, to avoid overcompensation, some member states have not allowed GOs to be issued to renewable energy facilities that have received subsidies. This risk of overcompensation is reduced gradually as subsidies

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31 https://www.giek.no/power-purchase-guarantee/

32 See e.g. WindEurope (2016), WindEurope's views on curtailment of wind power and its links to priority dispatch

33 See e.g. Re-Source (2019), Key Policy Recommendations

34 See e.g. Re-Source (2019), Key Policy Recommendations

35 WindEurope (2017). Creating a business case for wind after 2020 and BEUC (2016), Current practices in consumer-driven renewable electricity markets

are becoming auction-based since renewable energy developers can factor the revenue from selling GOs into the business case and thus reduce the required subsidy.

Figure 15
Regulatory barriers to PPAs at the EU-level

Unequal treatment across borders	• Differences in whether market designs ensure compensation for renewable energy curtailments • Consuming power through PPAs means that companies can become ineligible for indirect carbon cost compensation • Restrictions on e.g. third party ownership, number of buyers per installation and number of suppliers per metering point • Differences in tax regimes and legal systems
Guarantees of origin (GOs)	• GOs system currently does not ensure transparent and traceable green electricity. Risk of double counting. • Some countries do not allow issuance of GOs if RE-facilities receive government support – even if only a minor share

Source: Copenhagen Economics (2019), Google's hyperscale data centres and infrastructure ecosystem in Europe, page 63

The European Commission has recognised the need to address such regulatory barriers. Recent regulation from the European Commission states: "Member states shall assess the regulatory and administrative barriers to long-term renewables power purchase agreements, and shall remove unjustified barriers to, and facilitate the uptake of, such agreements".[36] This provides an EU-wide push towards identifying these barriers and removing them.

2.2 POSSIBLE IMPACT ON THE HEDGING OPPORTUNITIES FROM THE DEVELOPMENT OF PPAS

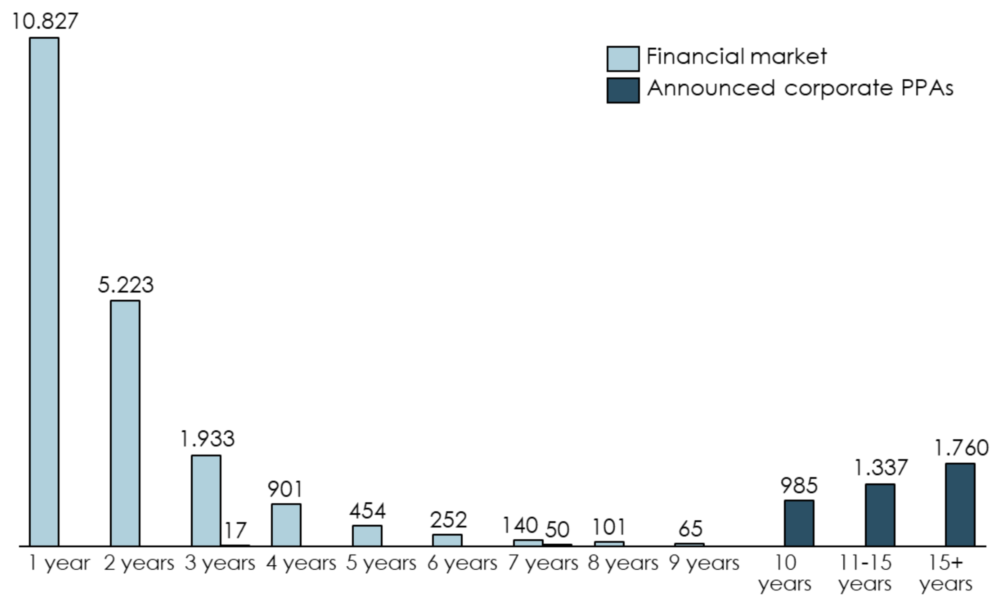
Sufficient hedging opportunities in the energy markets is an important goal for the European Commission. The Forward Capacity Allocation (FCA) guidelines stipulate that the forward markets should provide sufficient hedging opportunities for market participants between different bidding zones. If the hedging opportunities turns out not to be efficient, according to evaluation criteria set out in the FCA guidelines, long-term transmission rights must be introduced, or other measures must be implemented to ensure the efficiency of long-term hedging opportunities.

Different market participants have very different hedging needs with the main differentiating factor being the planning horizon. Some market participants look 10+ years ahead, while others are considering only a couple of years or maybe months ahead. This creates two different markets for hedging products. One is the futures tradable on exchanges and another is the PPA market.

36 Article 15(8) in the Renewable Energy Directive of the Clean Energy Package.

The financial future market is primarily used for shorter term hedges up to five years, whereas the PPA market is used for longer term hedges. This is evident when looking at the open interest (or total size of active contracts) which is decreasing over time for the financial market and increasing for PPAs. The size of active announced corporate PPA contracts agreed 10 years ahead is 985 MW, in comparison there were a similar amount (901 MW) open interest for a future 4 years ahead, see Figure 16.[37]

Figure 16
Open interest for Nordic financial market and PPAs split on deal horizon
MW



Note: Financial futures cover only a single year, while PPAs cover the entire period. PPA volume shown includes 27 announced corporate PPAs which are still active today. Financial futures only offered up to 10 years ahead. Open interest is only shown for annual future contracts. "Financial market" include open interest for system future and system deferred settlement futures. Open interest as of 23 December 2019.
Source: Copenhagen Economics based on data from Nasdaq Commodities and press releases from 2013-2019.

Despite being an important part of the long-term hedging opportunities, the PPA market has not been analysed in relation to the FCA in previous analyses in the Nordics.[38,39] In particular in Norway, the PPA market is larger than in the rest of the Nordics it may be more relevant to include in an analysis of the hedging opportunities of market participants.[40]

PPAs may in particular be a more interesting hedging tool for market participants located in bidding zones with either too few sellers or buyers to make an efficient financial market. In Norway

37 Here the open interest on the financial market covers a specific year, while the PPAs cover every year 10 years ahead.
38 See e.g. Houmøller Consulting (2017), Investigation of forward markets for hedging in the Danish electricity market and EC Group (2016), Methods for evaluation of the Nordic forward market for electricity
39 Although one mentions it is an opportunity, see EC Group (2016), Methods for evaluation of the Nordic forward market for electricity, page 25
40 Counting the announced PPAs.

however, the need for hedging the power price in a specific bidding zone is lower, due to the higher correlation with the system price.[41]

Impact on financial markets

The Nordic corporate PPA market has been growing the past 10 years, and at the same time the volumes in the Nordic future markets has decreased. However, despite the correlation, the increase in the corporate PPA market is mainly new capacity which was not already in the market.

The two major factors that have impacted the PPA market in recent years are a) data centres' and large global corporations' increased focus on ESG and b) new power capacity projects increasingly being driven by developers not directly associated with a utility. For both of these new participants, the financial future market is not an alternative. For a) because the additionality of being associated with a specific wind or solar farm is important, and for b) because lenders require a stable income stream to mitigate the risk of the large upfront investment. The existence of a well-functioning PPA market has therefore created hedging opportunities in addition to the opportunities in the financial markets.

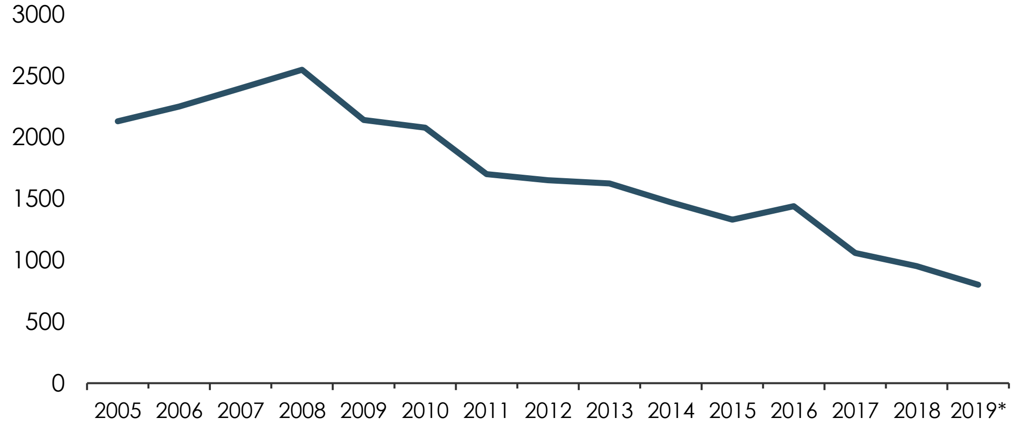
For traditional PPAs, most stakeholders see the financial future markets as a realistic alternative.[42] The main determinant for whether the market participants using traditional PPAs choose to hedge through a PPA rather than the financial markets is the price they can receive/pay.

A fair price on the future market is largely associated with good liquidity in the market. Liquid future markets are important to ensure sufficient hedging opportunities. Reduced liquidity will impair the efficiency of the futures market. Uncertainty about pricing signals can widen the bid-ask spread, hereby driving up costs for market participants.

As previously mentioned, the volumes in the Nordic financial future market as a whole has been decreasing in recent years. Since 2008, the total traded and cleared volume on Nasdaq has had a downward trend from around 2.500 TWh in 2008 to around 1.000 TWh in 2019, see Figure 17.

41 Houmøller Consulting (2017), Investigation of forward markets for hedging in the Danish electricity market, page 24
42 Based on interviews with relevant market participants.

Figure 17
Total traded and cleared Nordic financial power futures
TWh



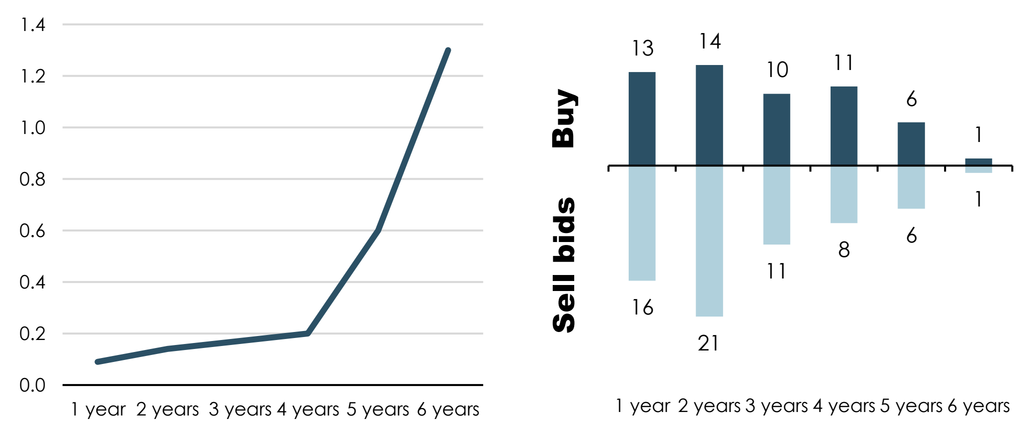
Note: Traded and cleared volumes for 2019 is calculated using December 2018-November 2019 since data for December 2019 is not yet available. Volume is total traded and cleared Nordic power derivatives.
Source: Nasdaq Monthly Market reports – European Commodities and Houmøller Consulting (2017), Investigation of forward markets for hedging in the Danish electricity market, page 15.

The cost of putting in large bids in the future market is quite high and attempting to purchase or sell a PPA of e.g. 100 MW over 10 years would be quite expensive. 1-3 years ahead, the bid-ask spread (difference between buy and sell bids) is low, indicating a relatively liquid market, however looking longer ahead, it becomes more (1.3 EUR 6 years ahead), see Figure 18. The size of sell and buy bids are between 5-20 MW.

Figure 18 Liquidity of financial markets is low in the longer term

Bid-ask spread for annual futures
EUR

Market depth for annual futures
MW



Source: Copenhagen Economics based on Nasdaq Commodities

Market participants that seek to hedge 50+ MW might circumvent the financial hedging market to avoid moving the market price. Individual trades in the financial market should not have an observable effect on the price. However, putting in a bid which is much larger than the market depth available might be very expensive since they can significantly affect the market price of the futures. To avoid this, market participants look towards hedging in the PPA market.

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