Investing in the Nordics:
the cost of the wind

Wind farms need to undergo regular maintenance to continue to efficiently produce energy, and this constitutes a major source of operational expenditure (opex) over the lifetime of a project. But how have costs evolved over time and what's in store for the next decade? We look to the Nordics to explore some of these questions, drawing on our experience in a market where Natural Power continues to see, and advise on, many major wind farm transactions.

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In this paper, Luke Gregson, senior advisory project manager, and Jeff Bryan, energy markets consultant, look at the Nordic market to explore wind farm operations and maintenance (O&M) trends, challenge conventional wisdom, and help owners and investors understand long-term opex costs.

1. HOW ARE O&M AGREEMENTS STRUCTURED?

For the purpose of this analysis, we've reviewed a range of broadly comparable 'full scope' O&M contracts offered by the original equipment manufacturer (OEM). These contracts are typically signed for a fixed number of years; however, in some cases there is the opportunity to terminate early. They cover both scheduled and unscheduled turbine maintenance and usually provide a guaranteed level of availability. For example, they may commit to making the turbines available to produce electricity 97% of the time. If the turbines do not meet this availability, the OEM will pay damages to the project that will recover the owner's losses. Bonus mechanisms may also be in place to incentivise the O&M provider to achieve more than the minimum availability. For example, the O&M provider will take a share of the revenue from the project where availability is greater than the guaranteed minimum availability.

Contracts are typically structured to include a fixed-base fee as well as variable fees based on the level of production by the turbines, as shown in **Figure 1**. The base fee acts as a 'floor' price and the variable fee provides financial upside for the contractor if wind farm production exceeds a certain level. Most contracts include 'step ups' in pricing at certain points during the contract term, so the base and variable fees will change throughout the project's life.

O&M contract pricing structure

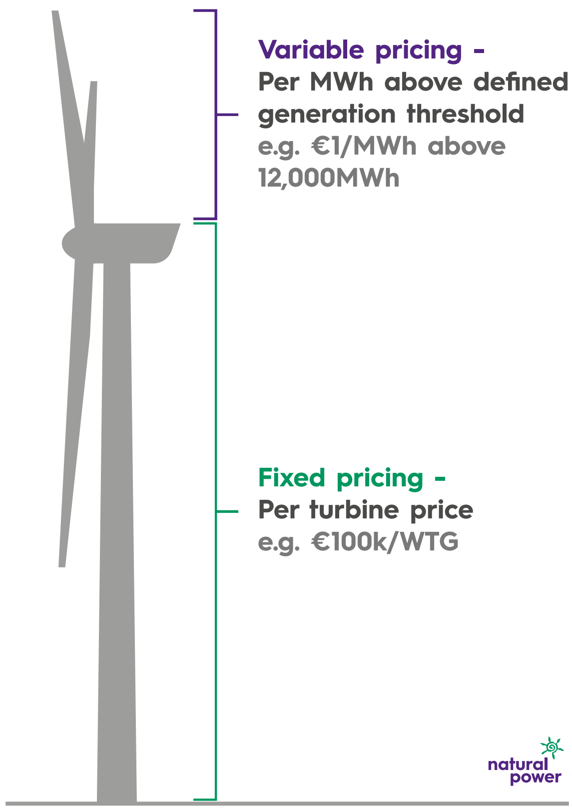


Figure 1: O&M contract pricing structure

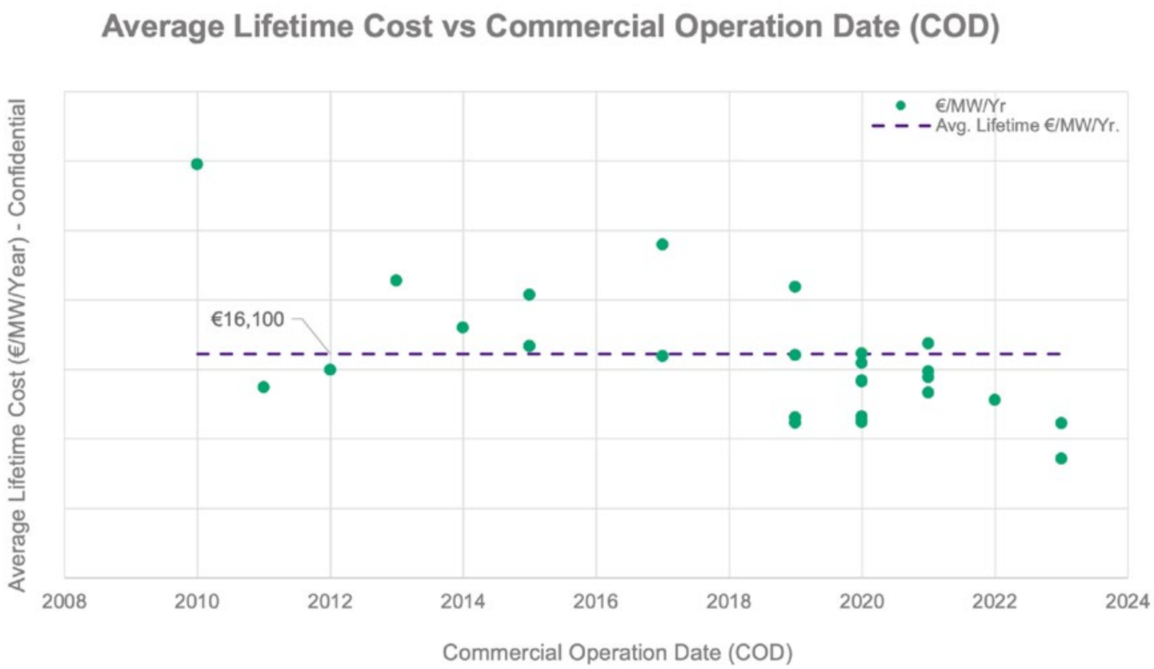
To analyse the expected fees incurred on a project over its lifetime, it is important to understand the wind farm's expected energy generation to calculate the variable fee and use this where it is greater than the base fee. By taking the 'P50' net energy yield of the project – the expected output in a given year – we are able to calculate the average O&M cost throughout the lifetime of the project. We express this as a fee per installed megawatt and per year (€/MW/Yr).

For simplicity, the analysis of the fees does not take into account indexation, as contracts may vary between indexation benchmarks. Our analysis includes data from over 30 wind farm O&M contracts signed in the Nordic market in recent years. We've excluded project-specific details for confidentiality purposes, although we have provided averages.

2. WHAT ARE THE FACTORS DRIVING O&M PRICING?

Firstly, we analysed the general trend in O&M pricing. Across the whole sample size, the average price is €16.1k/MW/year, though exact fees are removed from the axis for confidentiality reasons. We can see that O&M prices over a project's lifetime are decreasing, as shown in **Graph 1**. The overall trend is in line with wider market dynamics, where renewables are increasingly competitive with conventional energy sources as a result of decreasing capital expenditure (capex) and opex costs.

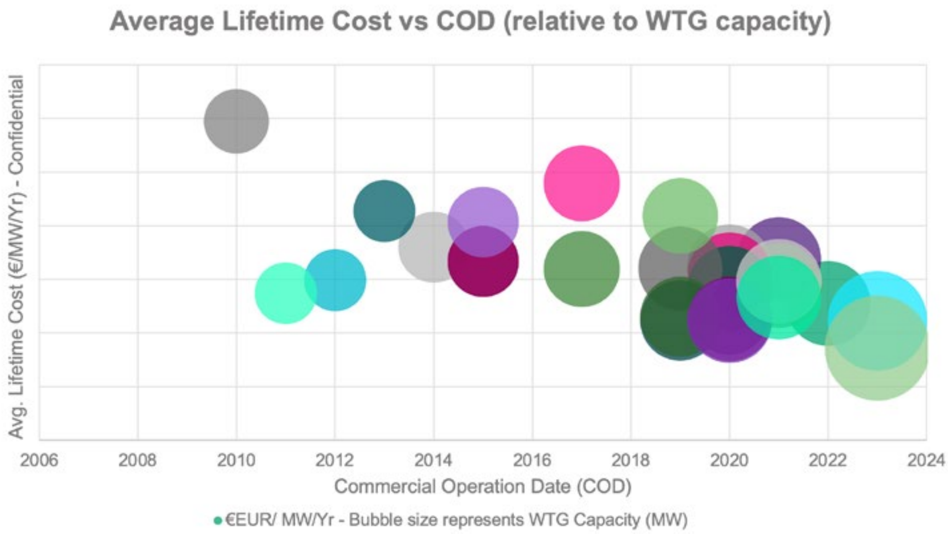
Drilling down deeper into the drivers of wind turbine opex, we find that the reduction in O&M costs goes hand in hand with an increase in turbine size.



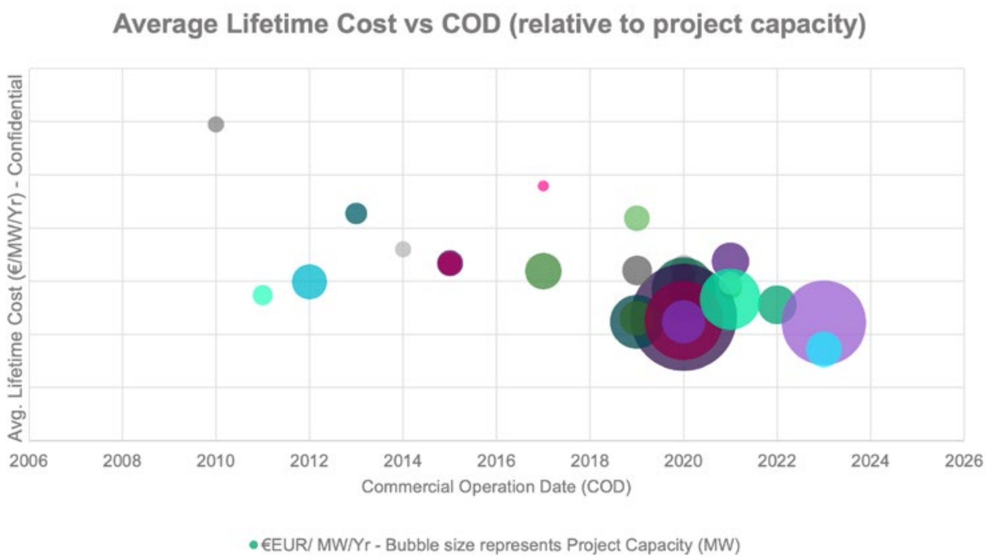
Graph 1

You can see this in **Graph 2**, which plots O&M costs against turbine capacity. It is reasonable to assume that the maintenance effort for a 100 MW wind farm consisting of 25 large turbines will be lower than a 100 MW wind farm consisting of 50 smaller turbines. Therefore, our view is that the shift towards 4 MW+ turbines being deployed in the Nordics is acting as the primary downward driver on maintenance costs. Data we are beginning to see on projects using the next generation of WTGs with capacities exceeding 5 and 6 MW (but which is not included in these graphs) reinforces this trend.

In addition to bigger turbines, in recent years we have also seen Nordic developers proposing larger projects. In fact, the typical size of wind farms constructed and permitted in the Nordics since the start of 2020 is well above 100 MW, whereas projects commissioned before 2020 averaged only 45 MW. As seen in the **Graph 3**, these larger sites tend to have an overall lower O&M cost throughout their lifetime, which is likely due to the 'economies of scale' of servicing a larger fleet of turbines.



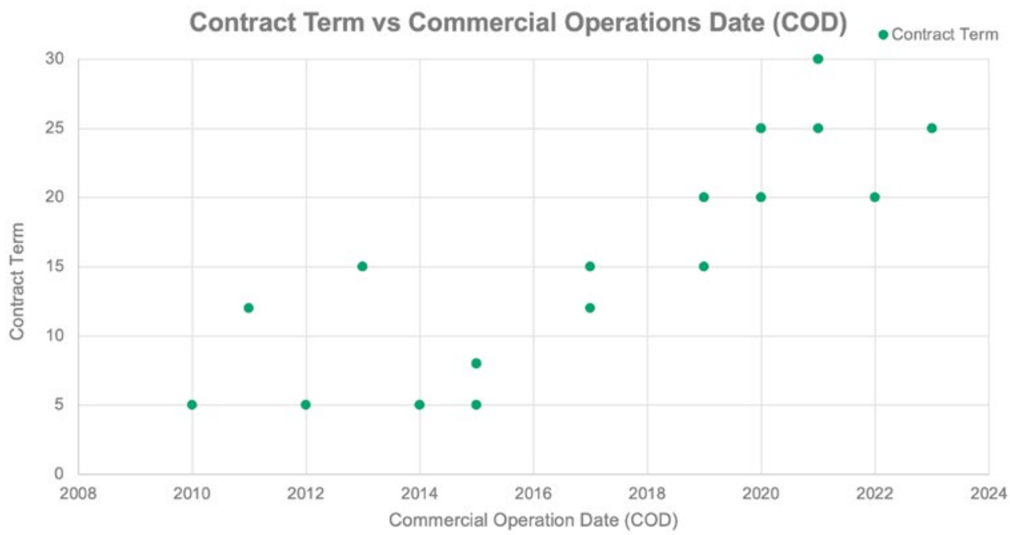
Graph 2



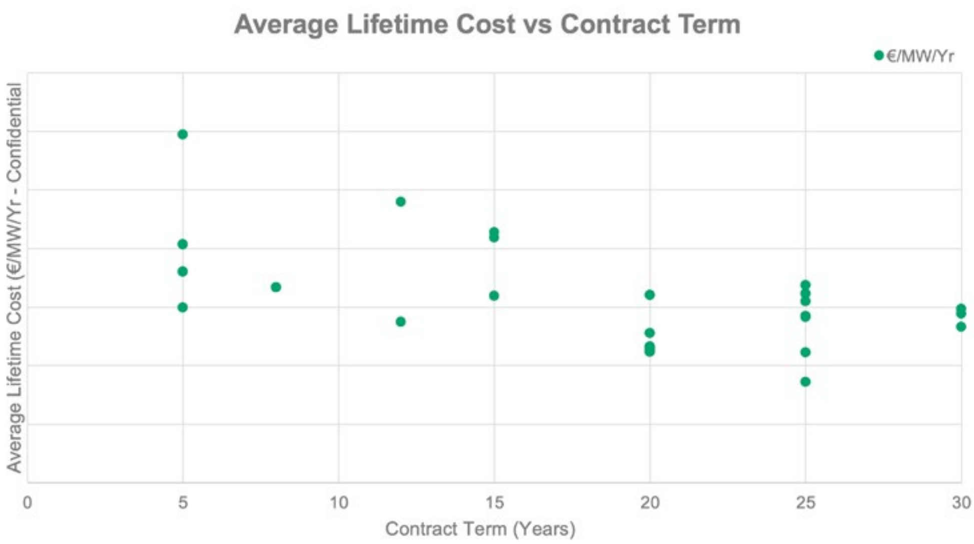
Graph 3

A final driver we examined is the length of the O&M contract. As **Graph 4** shows, O&M contract terms have been increasing in recent years. Prior to 2018, wind farm owners tended to sign up to 5–15 year contracts, whereas newer projects are committing to 15–30 year terms. This may be due to the types of investors entering the market and their preferred structures, or OEMs looking to secure longer-term maintenance contracts alongside their installation contracts. It is also worth noting that OEMs are likely able to offer 20-plus years contract terms due to increased confidence in the market that wind turbines can be safely and efficiently operated for longer durations than previously estimated. It may also be possible that owners signing up to longer O&M contracts are able to negotiate lower average costs, as suggested in **Graph 5**.

While **Graph 5** suggests that longer-term contracts lead to a decrease in cost per MW, we must also consider the fact that longer contracts more frequently correspond to projects with larger turbines.



Graph 4



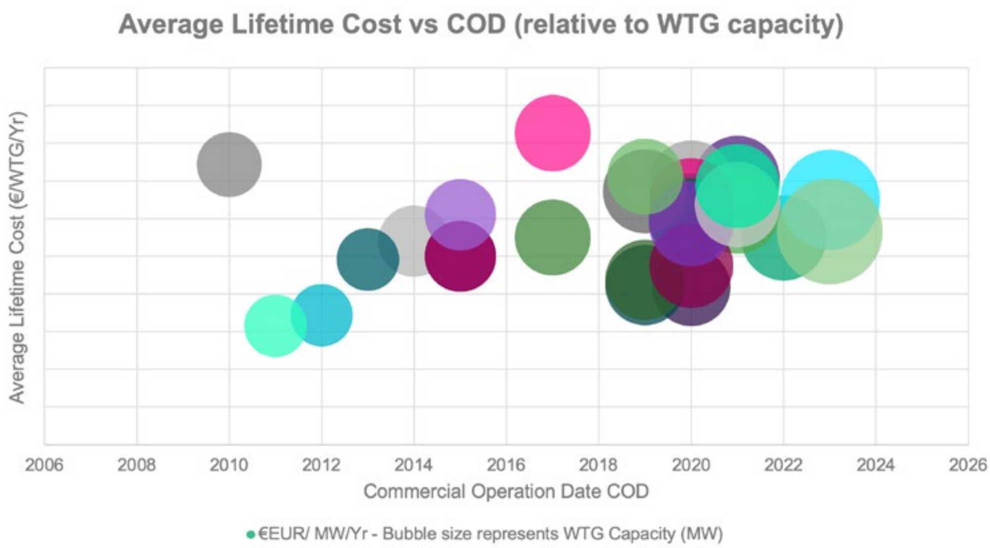
Graph 5

Graphs 6 represents the average lifetime cost on a per WTG basis, rather than a per megawatt basis, with bubble size representing WTG capacity. Interestingly, this shows a slight upward trend in O&M costs over time and as WTG capacity has increased. In part this is likely to be due to the cost of replacement components (e.g. blades, gearboxes) being larger for higher capacity WTGs. It does also, however, raise the question of the extent to which O&M providers are leveraging efficiencies or new methodologies to drive cost savings down, or whether cost savings are purely the result of larger machines installations?

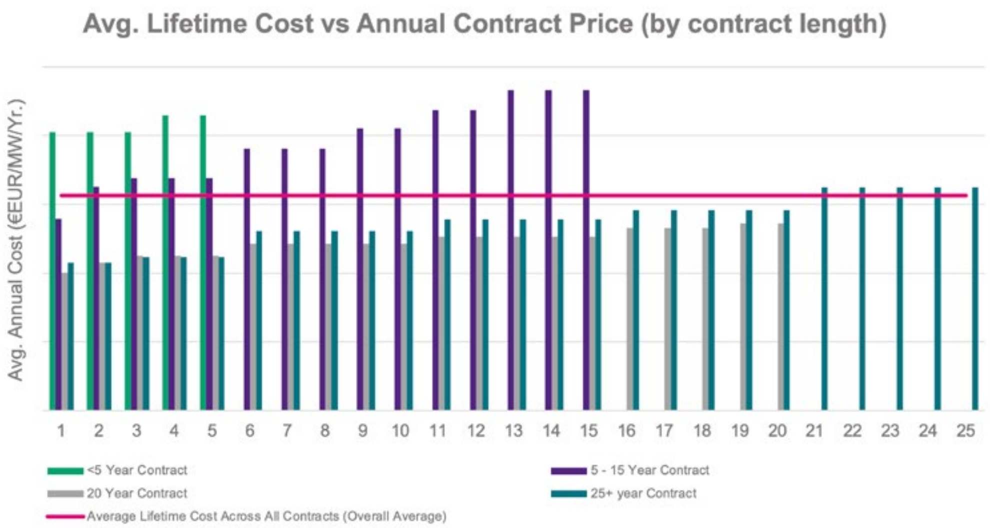
3. HOW DOES O&M PRICING CHANGE OVER A PROJECT'S LIFETIME?

As discussed in section 1, we typically see a series of 'step ups' in O&M fees over the term of the contract. This is illustrated in **Graph 7**.

We can see that the shorter-term contracts of <5 years and 5–15 years are more expensive on average than longer-term contracts, but this is significantly influenced by the fact that shorter term contracts were more common in the past when prices were higher. Therefore **Graph 7** also demonstrates again the overall reduction in cost/MW which is observed in the sample between older and newer projects.



Graph 6



Graph 7

The lower prices now offered over a long term provides reasonable incentive to procure O&M services for longer periods, although this may provide projects with less flexibility to the owners and any future buyers.

Where longer-term contracts are awarded, the initial years are typically priced below the average lifetime contract fee but steadily rise throughout the lifetime of the contract. Interestingly, we can see that there is typically a significant step up in fees from year 20 onwards. This results in fees that exceed the overall sample average. We also see that annual costs, on a per MW basis, are on average higher in all years of contracts with 25-year terms compared to those with 20 year terms. This may be because the increasing age of turbines gives rise to higher rate of failures, and in these latter years of life there will be a higher cost associated with maintaining the turbines and achieving the guaranteed availability. It can be noted that many turbines have a certified design life of 20 years, though some OEMs are prepared to offer site specific O&M contracts to 25-30 years, thereby indicating a willingness to cover full scope O&M beyond 20 years.

4. CONCLUSIONS

We have analysed a large sample of wind turbine O&M contracts signed in the Nordics to investigate trends in O&M contract fees and structure. Key takeaways include:

- O&M costs in the Nordics are falling on a per MW basis. Projects that will be operating from 2020 onwards will on average pay 25% less for their turbine maintenance (on a per MW basis) than projects built in 2010-2018. This is a clear, positive trend in support of renewables becoming the cheapest form of electricity generation and driving the transition to net zero.
- This cost reduction is likely due to a combination of factors, including economies of scale arising from larger machines and larger projects, longer contract terms, competition in the market and, potentially, are also due to more efficient O&M practices and more reliable WTGs. It is difficult to isolate the impact of each of these drivers, and the underlying dynamics may well be of little importance to investors.
- An interesting observation from our dataset is that when considered on a per WTG basis rather than a per MW basis, O&M costs are in increasing. This raises the question of the extent to which potential efficiencies in O&M practice have been realised yet, or whether cost reductions will only come from increasing turbine capacities.
- The increasing length of contracts can be beneficial to investors and lenders who are looking for price clarity and stability throughout the lifetime of a project. While we have found that longer term contracts offer better value than the shorter-term agreements that used to be common, it would appear that owners still pay a premium in all years of operation to secure O&M contracts that are longer than 20 years.
- Onshore wind turbines may reach a size limit due to planning restrictions and concerns over visual impact. This has already affected wind farm developments in more permit/landscape sensitive markets, such as the UK. In such markets it may not be possible to see price reductions on a par with those observed in the Nordic region. It remains to be seen in general whether O&M costs will continue to fall as providers become more efficient and competitive, or whether they will level out. For offshore wind farms, where turbine size continues to increase rapidly, further cost reductions are likely to be made on the basis of economies of scale.

For further information on O&M benchmarking, or any details within this paper, please contact

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