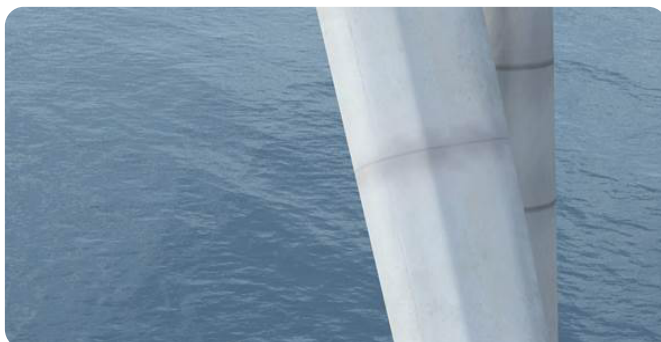




Peer Review of SWEKO Report on Investability of Offshore Wind in Sweden

*SWEKO: "Indikativ analys av objektiva lönsamhetsföretusättningar for
havsbaserad vindkraft"*

Prepared for the Swedish Government Commission on Offshore Wind
November 2024

Bringing Ingenuity to Life

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1 Executive summary

- (1) PA Consulting have been asked by the Swedish Government Commission on Offshore Wind to peer review an analytical report by SWECO on the investability of offshore wind in the Swedish market.
- (2) PA Consulting's offshore wind experts have many years' experience advising investors on business cases, returns and commercial models in the leading markets in Europe and across the world.
- (3) Our specific task was to review the report and comment on the robustness of the:
 - a. Methodology
 - b. Input assumptions; and
 - c. Conclusions
- (4) Methodology and approach - The approach taken by SWECO to understanding whether offshore wind is investable and profitable in Sweden is a standard one across the industry. The practice of calculating the LCOE of a project (or a suite of projects, or creating an LCOE heatmap) and comparing this to the potential revenues that could be earned by such a project is a standard approach to assessing the potential profitability of an electricity generation asset. We raise a number of points of clarification or different perspectives on how this type of analysis is generally carried out, but none of these issues we believe would materially change the main conclusion.
- (5) Input assumptions – We have reviewed a number of the most important input assumptions that have the highest impact on costs and revenue modelling. While we set out several remarks and differences of perspective or approach, we consider that the key input assumptions appear to fall within reasonable bounds.
- (6) Conclusions - We agree with the report's conclusion that offshore wind investability is highly challenging in Sweden at the present moment. The revenues available to offshore wind projects from the power prices in price zones SE1-4, do not appear to provide much or any profit for an investor given the cost of building and operating the windfarm.
- (7) In such circumstances and given that international energy companies that have the balance sheets and capabilities required to finance and build offshore wind have a range of markets in Europe to choose where they deploy their capital to get the best return, it seems unlikely that many will deploy large amounts of capital to build offshore wind in Sweden under the current regulatory and market regimes.
- (8) In general, there is no market in the world where offshore wind has been successfully financed and built at scale that does not provide the developer with either a revenue support mechanism (e.g. CfDs like in the UK, France, Ireland, Poland, Norway) or where the state pays for the transmission infrastructure (e.g. Germany, Netherlands).

2 Introduction and objectives

2.1 The task

- (9) PA Consulting has been appointed by the Swedish Government Commission on Offshore Wind to advise in relation to the investability of offshore wind in the Swedish market. Specifically, we have been asked to conduct a peer review of a report by SWECO, a well-known Swedish engineering consultancy, on the investability of offshore wind in Sweden.
- (10) The PA team conducting this review was led by Alon Carmel, partner in the London office and the head of offshore wind at PA Consulting. Oskar Almén a partner in the Stockholm office of PA, and head of energy across the Nordic region, and Torbjörn Severinsson a Managing Consultant in the Stockholm office.
- (11) We have reviewed the SWECO report in three main dimensions:
 - a. The approach and methodology
 - b. The input assumptions
 - c. The conclusions and how they are supported by the analysis
- (12) Caveats and limitations: The scope of our peer review was limited to commenting on the above 3 questions based on reading the report. No review of the actual modelling or the models used by SWECO has been conducted. Nor have we compared SWECO's market price forecasts with PA Consulting's own market modelling and price forecasting results for Sweden, or indeed any other power price forecaster, nor with current forward price curves. We have also been limited for reasons of scope to reviewing the analysis for electricity production and sale and have not reviewed the analysis of hydrogen production business models.

2.2 Background and context

- (13) Offshore wind is a well-established electricity generation technology that has become a cornerstone of the global energy transition since the first offshore turbines were commissioned in 1991. Growth in offshore wind generation worldwide has been driven by advancements in turbine and related technologies, the introduction of government revenue support schemes such as CfDs or PPAs, and major state sponsored investment programmes in transmission infrastructure. Global installed capacity has reached 75 GW as of November 2024, with an additional c.156 GW in development or under construction (of which just under half is in Europe).¹ Offshore wind is highly capital intensive and generally requires many billions of Euros to be spent at risk by developers in order to move from development phase to construction and operations.
- (14) Like other Scandinavian markets, Sweden has significant offshore wind potential due to its long coastline and good wind resource. However, Sweden remains a late mover when it comes to offshore wind with just 192 MW of installed offshore wind capacity, and no new projects commissioned since 2013.
- (15) The Swedish government established a commission in May 2023 to review the nation's offshore wind regime and regulation. In March 2024, the Swedish government expanded the commission's objectives to include a review of the seabed licensing process.

2.3 Our experience

- (16) PA Consulting Group is a strategy and innovation consultancy providing advice to investors, major corporations and governments across a range of industries and global markets. PA was founded over 75 years ago and has more than 4,000 employees across the UK, Europe and the US, including offices in Stockholm, Oslo and Copenhagen. We have a large Energy & Utilities practice with over 200 consultants globally, and work across the value chain to help our clients thrive in complex energy

¹ 4C Offshore, Current Project Status & Capacity. November 2024.

markets while deploying new capital. We support our clients with business and market strategy, asset optimisation and innovation, investment, M&A, transaction support, valuations and expert witness testimony. Our work in the energy sector is underpinned by technical and commercial understanding of energy technologies and markets, as well as deep economics, regulatory, financial and strategy expertise.

- (17) PA's offshore wind team has many years' experience advising investors, developers and governments across European, North American and Asian markets. Our services cover commercial and investment strategy, transactions and M&C, supply chain strategy and market design. We regularly support developers, investors, OEMs, governments, and regulators across a range of key markets and propositions.
- (18) Alon Carmel serves as PA Consulting's Head of Offshore Wind. Alon is a Partner in PA Consulting's London office with over 15 years of experience advising energy companies, utilities, investors and governments on strategy and how to realise the opportunities within the energy transition. Alon advises international energy companies and investors on offshore and onshore wind valuations, revenue and commercial models (e.g., PPAs, CfDs, etc.), investment and portfolio strategy, auction strategy, new market entry and global acquisitions. He also regularly advises governments on energy market design for renewables. Before becoming a consultant Alon led teams within the UK Department of Energy and Climate Change (DECC) developing policy on electricity market design, renewable energy regulation and carbon pricing. In particular he led teams that designed the CfD revenue support scheme for renewables, nuclear and CCS, as well as the auction for allocating CfD contracts to renewable energy generators. Further information on Alon Carmel's experience and credentials can be found in [\[Appendix 1\]](#).
- (19) Dr. Oskar Almén is a Partner in PA Consulting's Energy & Utilities practice, based out of the Stockholm office. Oskar has two decades of experience working at the forefront of the new European energy landscape through several leading positions in pan-European energy companies and strategy consulting projects for companies, municipalities, regions, and authorities. He has developed a deep understanding of market drivers and their consequences on the traditional business model, as well as the new competitive landscape that is rapidly changing the playing field as global companies expand their operations to ensure sustainable production. Oskar frequently acts as a trusted advisor to decision-makers in well-established energy companies, as well as new players and start-ups in the energy sector. Further information on Dr. Oskar Almén's experience and credentials can be found in [\[Appendix 1\]](#).
- (20) Torbjörn Severinsson is a Managing Consultant in PA Consulting's Energy & Utilities practice, based in the Stockholm office. Torbjörn has close to 20 years of experience within the energy sector. Before joining PA Consulting, Torbjörn worked for Vattenfall in various roles for 11 years. His experience ranges from designing and implementing strategies to maximize returns on investments in renewable energy (especially wind power) to establishing partnerships and collaborations to accelerate the energy transition. Torbjörn has extensive experience in analysing the profitability of both onshore and offshore wind power through serving as project manager for numerous projects in offshore wind power and providing expert valuations in onshore wind power. Further information on Torbjörn Severinsson's experience and credentials can be found in [\[Appendix 1\]](#).

3 Peer Review

- (21) In this peer review we have read through the SWECO report and considered the robustness of their approach and methodology, their input assumptions and the conclusions they draw. We have paid particular attention to whether the conclusions are well supported by the evidence and analysis presented. We have drawn on our many years of experience of advising investors and major energy companies on strategy and business cases in offshore wind to form our assessment.

3.1 Commentary on Approach and Methodology

- (22) The approach and methodology used by SWECO for this analysis is standard and widespread within the industry.

- (23) Developers considering investing in offshore wind in a new market will often undertake LCOE (levelized cost of energy) analysis to understand approximately how much it would cost to produce a MWh of electricity from a hypothetical windfarm at a particular location given windspeeds, water depths, seabed characteristics, distance to shore, connection point and so on. It is also standard to compare the LCOE with the potential revenues for the generation asset in that particular market – such as revenues from selling merchant power into the market, or longer-term contracts such as PPAs or CfDs. The purpose of comparing the LCOE to revenues is to form a first-pass assessment of whether an investment in the energy generation asset in this market would be profitable and provide a reasonable return, commensurate with the risk involved in developing, permitting, constructing and operating the windfarm.
- (24) It is also standard to create LCOE heatmaps covering a range of potential locations to gauge which locations are more and less cost-effective.
- (25) It is worth noting that LCOE and revenue analysis is not the only way to assess investability in a new market, nor is it comprehensive. A more in-depth assessment would include financial modelling of a potential wind farm to consider the return (IRR, internal rate of return) and NPV (Net Present Value) and potentially measures of profitability directly.
- (26) There are few if any objections from our point of view to the approach and methodology.
- (27) Some minor comments include:
- a. The treatment of inflation should have been addressed more clearly and extensively. It is not clear whether the LCOE are in real terms (and if so what the base year for the modelling is) or in nominal terms. Likewise for the revenue and power price modelling it is not specified whether these are in real or nominal terms.
 - b. Relatedly the discount rates (WACC) used should have been explained and described more extensively – in particular whether the analysis uses a pre-tax real discount rate or a post-tax nominal. It is important to be clear that the treatment of input assumptions with regards to inflation and tax and the use of the discount factor are consistent.
 - c. Investors will generally use a hurdle rate rather than the WACC itself when making an investment decision – to capture the fact that there is normally a risk premium added on top of the WACC itself to capture the specific risks in that market.
 - d. The treatment of taxes, depreciation and capital allowances could also have been more clearly explained in the modelling.
 - e. In the power market modelling there is an interdependency or circularity between the amount of offshore wind assumed to be built out and the resulting prices. This could have been more directly addressed and explained in the report in order for the reader to better understand the complexities of modelling power markets and how to interpret the resulting power price forecasts.
 - f. It is also important to acknowledge that power prices so far into the future are inevitably subject to very significant uncertainty. There will be some forecasts and scenarios with prices above the LCOE ranges quoted by SWECo. However, we consider that the uncertainty of these future revenues will inevitably lead investors to treat them with caution, and apply high hurdle rates when making an investment decision that is dependent on highly uncertain future revenues from uncontracted merchant power markets.
 - g. Some of the terminology used is unusual or not standard in energy economics. For example the report talks about the gap between the revenues and the LCOE as “missing money”. However, this concept is more regularly used to refer to a well-defined problem in energy economics – the perception that regulatory authorities will not allow power prices to spike beyond a certain level to fully remunerate generators in times of scarcity or constraints, leading to the introduction of capacity markets.
 - h. The presentation of the revenue side analysis (price forecasts) is also somewhat unclear – the report presents a range of revenues without specifying whether this is the maximum capture prices that offshore wind could achieve in any year between 2024 and 2050, or whether it is some sort of average (and to what extent the time value of money is taken into account in the revenue figures quoted).

3.2 Commentary on Input Assumptions

- (28) We have reviewed a number of the major input assumptions – generally they fall within reasonable ranges for this type of analysis. In particular we have commented on some of the key drivers of value and cost below.
- (29) Technology choice inputs – the technology choices in general seem reasonable for the type of water depths and site characteristics analysed (albeit there is relatively little site data is available). The turbine sizes modelled also seem a reasonable set of generic turbine sizes that might be considered by developers in the Swedish market, though the presentation of them as specific models of SK turbines is somewhat confusing. Foundation technology choices and expectations of the use of monopiles, jackets and other foundations also seems reasonable and in line with what we have experienced elsewhere.
- (30) The transmission technology choices such as HVDC versus HVAC systems seems generally reasonable. For HVDC cable systems we note that there are some instances where these have proven lower cost even for distances lower than 175km. Likewise we note that there are currently sites being developed in other parts of the world where monopiles are being planned for water depths greater than 50 metres. However, these are the frontiers of the technology development in transmission and foundations and it is a reasonable choice to focus more on the well-established technology options for the site characteristics.
- (31) Cost inputs – the cost inputs across capex, opex, devex and decex are within reasonable ranges given the lack of precedent in the Swedish market and the inevitable uncertainty that affect cost estimates for projects at such an early stage of development. If anything we consider that recent supply chain inflation and bottlenecks would suggest that higher cost assumptions would be justified. There are also generally other capex related items such as project management, insurance and contingency which may or may not be taken into account as these sub-categories are not addressed. The potential for economies of scale for windfarms above 1.4GW in size could have been further considered. Likewise operational synergies from siting two or more windfarms close together and sharing maintenance vessels or other infrastructure could have been further considered.
- (32) The cost estimates are subject to considerable uncertainty – not least because the big ticket capex packages such as turbine supply and installation, foundations and transmission system (export cables and sub-stations) are all going through significant market turbulence at the moment, with major changes taking place in the supply chain and OEMs entering and leaving the market as well as changing strategy and approach. It is for example possible that Chinese wind turbine OEMs such as MingYang, Goldwind and others will start to sell offshore wind turbines in Europe within the next few years. This could reduce costs. However, we consider that SWECO's approach of basing the analysis on more conservative assumptions and existing suppliers is sensible.
- (33) It would have been good to say something more explicit about the source of the cost estimates (beyond saying that they come from the SWECO tool WindCostimator).
- (34) There could have been further clarification or breakdown of opex and in particular O&M (Operations and maintenance) costs as this is a significant portion of total LCOE.
- (35) Grid connection costs - Since the connection capacity in the transmission grid for offshore wind power is in reality limited to certain connection points, this means that the grid connection cost has been underestimated to varying degrees in the analysis. The actual cost is therefore higher for most points. The reason for this methodological choice is that SWECO assessed that an analysis where the grid connection cost is calculated based on the connection points communicated by Svenska Kraftnät would make the analysis less neutral in terms of objective profitability conditions and overly tied to Svenska Kraftnät's assessment.
- (36) It is also worth pointing out that connecting significant offshore wind capacity could require reinforcement of the onshore grid and this could result in further costs being levied on the projects.
- (37) It is not clear how network charges have been included in the analysis. Nor is it clear how balancing costs are included if at all for the hypothetical windfarms. However, if these costs are not yet included in the calculation, that would further strengthen the main conclusions on investability.
- (38) Wind yield and annual energy production – the analysis of wind yield and energy production appears to follow standard approaches and use reputable datasets. It would have been good to specify more clearly whether the capacity factors referenced in the report are net or gross capacity factors, and to

expand on the treatment of losses (such as from electrical transmission, or wake losses) in the analysis. Energy yield optimisation is of course likely to be possible to a level beyond that conducted for the report, as the turbine layouts are unlikely to be fully optimised at this level of generic site analysis. However, that is in our view unlikely to change the main conclusions from the analysis.

- (39) Revenue inputs – the power price modelling approach followed by SWEKO appears to us on the whole to be standard and does not raise major concerns. We have not within the scope of this review been able to compare the power price forecasts with PA Consulting's own power price modelling, nor that of other providers. However, the levels of captured prices for offshore wind seem within the ranges of power price forecasts we have seen for the Swedish market. Further comments about whether the prices are real or nominal and specifying the price base year are important, but covered in section 3.1 above.
- (40) It is notable that all the power price scenarios presented from the modelling by SWEKO have rising power prices out to 2050. There are reasons however to believe that the continued expansion of renewable generation may push future prices downward due to those technologies having generally very low marginal cost of production (and assuming that market rules and price formation remains as a marginal pricing market). If these scenarios were taken into account however, that would further undermine the investability of offshore wind on a merchant basis.
- (41) Long term price contracts such as PPAs are used regularly in the Swedish market and would be available to offshore wind developers – though these would be at a discount to the expected capture prices and therefore should not change the key conclusions of the analysis.
- (42) Financing costs and discount rates – the range of discount rates used is appropriate for this type of analysis, based on our experience of working with a range of different investors, energy companies, utilities and developers. The use of a highly precise discount rate of 8.7% in the base case modelling is at risk of communicating a false accuracy, and it may be more appropriate to use a range of discount rates. The derivation of the 8.7% is not fully explained. Given the high level of risk in the Swedish market both on the regulatory, cost and revenue sides, we would expect many if not most investors to require returns towards the higher end of the range presented. Other comments about the definition of discount rates and the treatment of inflation are important but covered in section 3.1 above.

3.3 Commentary on Conclusions

- (43) We consider that overall the methodology is well-suited to answering the question from the Swedish Government Commission, at least to a first approximation.
- (44) We believe that the approach to the LCOE modelling and to the revenue or power price modelling has been standard, and from a high level review the ranges used for key input assumptions are reasonable.
- (45) The analysis as conducted clearly leads to the conclusion that investment in offshore wind in Sweden (reaching financial investment decision and spending large amounts of capital on capex items such as procuring and installing foundations, turbines, sub-stations and cables) is extremely challenging under present market and regulatory conditions. This is due to the combination of high regulatory uncertainty, high risk of delays or unfavourable decisions along with low revenue potential and high risk around revenues due to the absence of a CfD mechanism or some other form of state supported PPA contract as provided in countries like the UK, Ireland, France, Norway, Poland and the US. Furthermore there is no state support on the grid connection or transmission capex as there is in countries like Germany and the Netherlands.
- (46) Therefore we consider that the conclusions drawn are well supported by the evidence and the analysis, and are in line furthermore with our perspectives on the challenges in the Swedish market and our experience from advising potential investors across Scandinavian and northern European markets.

4 Conclusions

- (47) We have conducted a peer review of the SWECO report “Indikativ analys av objektiva lönsamhetsförtusättningar for havsbaserad vindkraft” on the request of the Swedish Government Commision on Offshroe Wind. We considered in particular the:
- Approach and methodology
 - Key input assumptions
 - The conclusions drawn
- (48) Our findings are that overall the approach and methodology are sound, the input assumptions are generally within reasonable ranges and that the conclusions follow logically from the analysis. We have outlined above minor comments and different perspectives on the methodology and the input assumptions used. However, we do not believe that these points would materially change the conclusion.

Appendices

Appendix 1: PA Consulting team CVs



Alon Carmel

Partner, Energy & Utilities

Alon is a Partner in PA Consulting's Global Energy and Utilities Practice and leads much of PA's work in European offshore and onshore wind. He has over 15 years of experience advising energy companies, utilities, investors and governments on strategy and how to realise the opportunities within the energy transition. Alon advises international energy companies and investors on offshore and onshore wind valuations, revenue and commercial models (PPAs, CfDs), investment and portfolio strategy, auction strategy, new market entry and global M&A. He has practical expertise in energy market design, carbon pricing and climate change regulation. In offshore wind Alon has advised bidders in many seabed and PPA auctions.

Alon has advised several European governments and other public institutions on market design for renewable energy including auction or tender design for offshore wind seabed leases and revenue support mechanisms (PPAs, CfDs). Alon regularly leads M&A and commercial due diligence teams to value wind assets and support investors throughout the transaction. Alon has advised governments, investors and energy companies across Europe on energy market design and in particular support schemes for renewable energy and nuclear. He spent 5 years in the UK Department of Energy and Climate Change (DECC) leading policy and regulatory design for electricity markets (2010-2014), designing the CfD mechanism (a government backed PPA) for renewable energy technologies like onshore wind, offshore wind and solar, as well as new nuclear power and CCS. He also led work on the auction regime for allocating CfD contracts to renewable generation. Alon has also worked extensively on carbon taxation and carbon trading schemes.

Previous Positions

- FTI Consulting, Managing Director, Corporate Finance Practice, London, 2018 – 2022
- NERA Economic Consulting, Principal, London, 2014 - 2018
- UK Department of Energy and Climate Change (DECC), Senior Policy Advisor Electricity Market Design Team, various positions, 2008 – 2014
- UK Department for Transport (DfT), Government Economist, various positions 2006 - 2008

Education

- BA (Hons), Politics, Philosophy and Economics (PPE), Brasenose College, Oxford University, 1999
- MSc, International Relations, London School of Economics, 2000
- MSc, Economics, University of London (Birkbeck), 2005SSE

Languages

- English (native)
- Swedish (native)
- French (intermediate)



Oskar Almén

Partner, Energy & Utilities

Dr. Oskar Almén has spent the last two decades at the forefront of the new European energy landscape through several leading positions in pan-European energy companies and strategy consulting projects for companies, municipalities, regions and authorities. He combines insights from his academic research on the creation of competitive advantage and growth at the University of Cambridge, with practical analysis and advice in a time of high disruption and great change.

He has developed a deep understanding of market drivers and their consequences on the traditional business model, as well as the new competitive landscape that is rapidly changing the playing field as global companies expand their operations to ensure sustainable production. Oskar has been active in both media and research on the effect of rapid economic and social growth in the Nordic region, and its implications for the current infrastructure. He has participated in a number of projects to establish data centers and other energy-intensive industries, where a region and municipality's ability must match the needs of global players in their long-term investments.

Oskar is a trusted advisor to decision-makers in well-established energy companies, but also to new players and start-ups in the energy sector. Examples of this include projects where he has led and been responsible for conventional corporate strategy projects, either in a functional role within Utilities (Director European Market Strategy, Vattenfall; Director Customer and Market Analysis, Vattenfall Eldistribution), as a consultant (Strategic assessment of Hydro power performance; Sourcing strategy distribution; Strategic evaluation of grid congestion; Site selection strategy), and on a consultancy basis as interim manager (Executive responsibility energy strategy and operation for energy intense data center).

Previous Positions

- Vattenfall Eldistribution, Director Market Strategy, Stockholm, 2014 – 2016
- Vattenfall Group, Director Business Development, Stockholm, 2010 - 2018
- Capgemini Consulting, Head of European Energy Lab, Paris, 2007-2008
- Capgemini Consulting, Energy Team, Managing consultant, Stockholm 2006-2010

Education

- BSc, Business and economics, Stockholm university, 1999
- Mphil, Management and economics, University of Cambridge 2002
- PhD, Strategy, University of Cambridge, 2006

Languages

- English (native)
- Swedish (native)
- French (intermediate)



Torbjörn Severinsson

Managing Consultant, Energy & Utilities

Torbjörn has close to 20 years of experience within the energy sector. Before joining PA Consulting he worked for Vattenfall in different roles during 11 years, resulting in a very strong energy business understanding. By working closely with teams and stakeholders, Torbjörn has led successful projects that have promoted the transition to sustainable energy. His experience ranges from designing and implementing strategies to maximize returns on investments in renewable energy (especially wind power) to establishing partnerships and collaborations to accelerate the energy transition. In addition, he has experience in identifying and leveraging business opportunities in the energy transition for long-term growth, most recently within bio-CCS (BECCS).

Torbjörn has extensive experience in analysing the profitability of both onshore and offshore wind power. He has served as project manager for numerous projects in offshore wind power and its market conditions, as well as for expert evaluations in onshore wind power.

Previous Positions

- Business and Regulatory Management at Vattenfall Eldistribution AB – Business Strategist, 2016-2017
- Staff function Strategy and Asset Management at Vattenfall AB – Strategy Manager, 2015-2016
- Group Asset Management at Vattenfall AB – Asset Manager Corporate and Renewables, 2012-2015
- Business Unit Wind at Vattenfall Vindkraft AB – Analyst, 2009-2012
- Swedepower International AB (later Vattenfall Power Consultant AB - International) – Project manager / Consultant, 2006-2009

Education

- MSc in Industrial Engineering and Business Management
- Project Management

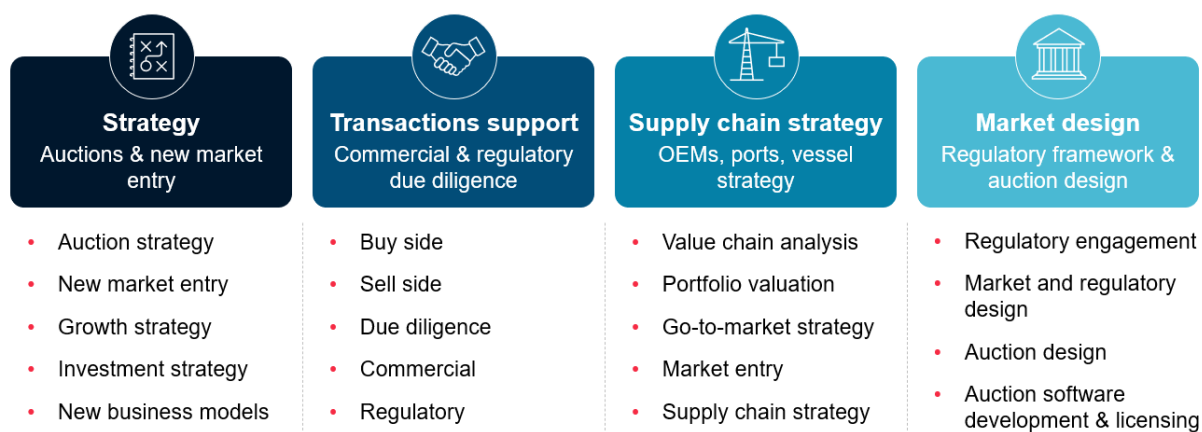
Languages

- Swedish (native)
- English (native)

Appendix 2: Overview of PA Energy and Utilities Practice

- (49) PA Consulting is a global professional services and advisory firm working with public, private and third-sector organisations. At PA Consulting, we believe in the power of ingenuity to build a positive human future in a technology-driven world. As strategies, technologies and innovation collide, we create opportunity from complexity. For over 80 years, our diverse teams of experts have combined innovative thinking and breakthrough technologies to progress further, faster. Our clients adapt and transform, and together we achieve enduring results. An innovation and transformation consultancy, we are over 4,000 specialists in transport and logistics, energy and utilities, consumer, defence and security, financial services, government, healthcare, life sciences and manufacturing. Founded in 1943, we have been a trusted advisor to many organisations for the last 80+ years.
- (50) PA is more than a traditional consulting firm: We're the only advisory firm to offer end-to-end innovation capability. Our diverse teams – including strategists, innovators, designers, consultants, digital experts, scientists, engineers and technologists – bring real-world experience and apply it at pace. We have c. 4,000 industry experts and work from 19 offices across North America and Europe, partnering with clients in a range of industries, including consumer and manufacturing, defence and security, energy and utilities, financial services, government and public services, health and life sciences, and transport.
- (51) PA has a full spectrum of capabilities in the Energy & Utilities space, as well as across wider sectors encompassing energy users. Since 2011, we have supported more than 700 energy infrastructure purchases, sales, financings or appraisals across a wide range of different types of assets. Our global team of over 200 energy market and utility advisors support clients across the energy value chain. Our key clients include a range of leading global utilities in the sector, across geographies and sectors.
- (52) Our Global Innovation and Technology Centre in Cambridge, UK, is the heart of our international network of design, engineering, and innovation centres. With 10,000 square meters of design studios, scientific laboratories, and engineering workshops, and 400 scientists, designers, engineers and technologists, where we turn ingenious ideas into physical and digital reality. Our integrated team works closely with our headquarters in London, UK, and our Studios in the US (San Francisco and Boston) and Ireland, delivering 40,000 innovations across industry, government, and defence to date. So, wherever you go, you'll meet people passionate about creating opportunity from complexity through great design. We leverage our scientific and product development capabilities to provide our technical consulting services across key energy transition areas: Electrification, CCUS, Hydrogen & Sustainable Fuels, and Water.
- (53) PA's offshore wind team has many years' experience advising investors, developers and governments across European, North American and Asian markets. Our services cover commercial and investment strategy, transactions and M&C, supply chain strategy and market design. We regularly support developers, investors, OEMs, governments, and regulators across a range of key markets and propositions.

Figure 1 PA Consulting's offshore wind capabilities





About PA.

We believe in the power of ingenuity to build a positive human future.

As strategies, technologies, and innovation collide, we create opportunity from complexity.

Our diverse teams of experts combine innovative thinking and breakthrough technologies to progress further, faster. Our clients adapt and transform, and together we achieve enduring results.

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Our teams operate globally from offices across the UK, Ireland, US, Nordics, and Netherlands.

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