WHEN TRUST MATTERS

SECOND WIND:

THE IMPACT OF CURRENT U.S. OFFSHORE WIND INVESTMENTS ON FUTURE COSTS

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REPORT

Contents


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1. Introduction

Stemming from the first wave of offshore wind (OSW) projects currently under construction in the United States (U.S.), many significant supply chain and infrastructure investments have been made by leveraging state, federal, and private sources of capital. These investments are the foundational building blocks for the emerging U.S. offshore wind sector, and their benefits are poised to be realized over the long-term expansion of the industry. However, given rising costs observed in recent years due to a rapidly changing macroeconomic environment coinciding with growing pains of a new market, some observers are unsure of whether these investments are delivering on their inherent commitment to contribute to cost reduction. Others contend that material cost reduction will be realized by future projects due to the investments already being made but find difficulty in quantifying this.

DNV studied the impacts of the supply chain and infrastructure investments that were largely enabled due to the first wave. For the purposes of this work, the "First Wave" comprises the 6 gigawatts (GW) of utility-scale offshore wind generation projects that are either operational or currently under construction and expected to be operational by the end of 2027. This report presents a quantitative analysis of the cost reduction impact that these investments will have on future OSW projects.

2. Approach

To measure investment impacts on project cost, DNV developed a study methodology, which included research, evaluation, and modelling. The methodology was intended to produce high-level but substantive conclusions. The study considered the site-specific conditions and proposed project arrangements of active lease areas along the U.S. Atlantic coast and thus, only relates to fixed-bottom offshore wind development. The analysis does not apply commonly publicized new technology commercialization curves, which can be simplistic in predicting that costs will decline over time. Rather, DNV considered 34 site-specific offshore wind projects, each in various stages of development along the U.S. Atlantic coast and used levelized cost of energy (LCOE) to quantify the impact of individual supply chain and infrastructure investments (hereinafter the "Investments").

It is not the purpose or intention of the study to provide a forecast of future offshore wind costs. It is an independent and unbiased estimation of the cost reduction impact of the Investments utilizing actual commercial data points and conservative methods. Other external sources of potential cost reduction such as cost of capital, technological advancements, supply chain maturation, and increased construction efficiency are not included in the study.

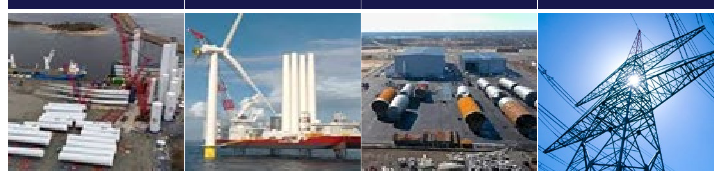
Key to the study methodology was the creation of a project-specific cost model using a standard approach to estimate project lifetime LCOE. The primary inputs to the model included: (i) the applicable Investments to be evaluated, (ii) estimated project costs, including cost for capital, and (iii) ~a viable project build-out forecast through 2036. Further details on how these inputs were developed and integrated into the cost model are provided below.

2.1 Summary of Investments

A variety of significant capital Investments have been made, or have a strong probability of being made, across the U.S. market. Through industry research, DNV identified and summarized key details of the Investments that met the following criteria threshold: (a) over $10 million, (b) strong probability of being completed, and (c) expected to impact multiple projects.

For the purposes of the study, the Investments were grouped together in one of four categories:

Ports	Vessels	Manufacturing	Transmission



A total of 23 Investments were included in the study, distributed between the above four categories. Each Investment was modeled separately, with DNV identifying which future projects are likely to benefit and to what degree capital (CAPEX), development (DEVEX), or operational (OPEX) expenditure obligations would be avoided.

The timeline of this study considers viable project build-out through 2036. However, today's investments into ports, vessels, and manufacturing are not then expected to stop delivering benefits. Future offshore wind development beyond 2036 will continue to see benefits from these investments, even though a quantification is not presented herein.

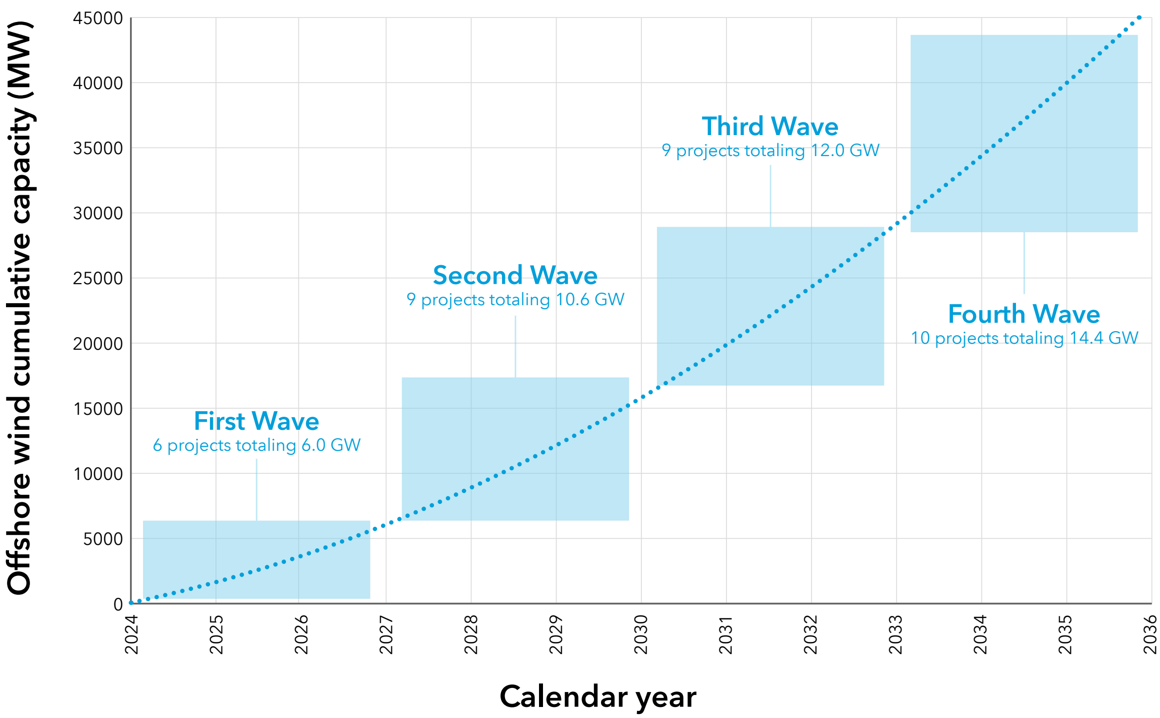
There is an important distinction to be noted for the transmission investment category, which consists of regional transmission system infrastructure upgrades, coordinated with newly proposed high-voltage (HV) transmission lines. These investments represent increased grid interconnection capacity that is "used up" by projects in the second, third, and fourth waves, as defined below. As such, their benefits to the industry do not go on in perpetuity.

2.2 Project buildout forecast

To estimate the impact of the Investments, DNV forecasted the buildout of the project pipeline qualified for the study. The forecast considered 34 individual projects in various stages of development, with component and system designs anticipated based on site specific conditions and geographies, as well as publicly available documentation. To determine appropriate commercial operation dates for each project within the forecast, DNV used a variety of internal and external references including status of relevant State procurements (i.e., offtake awards), status of federal construction and operations plans (COP), and self-reported public information regarding construction schedules.

Projects were classified into four waves, each approximately three years, as illustrated below:

FIGURE 1.2 TIME DISTRIBUTION OF PROJECT WAVES AND CAPACITY



The following definitions for each wave were used, along with publicly available information regarding maturity of each offshore wind development, to identify the appropriate wave for individual projects:

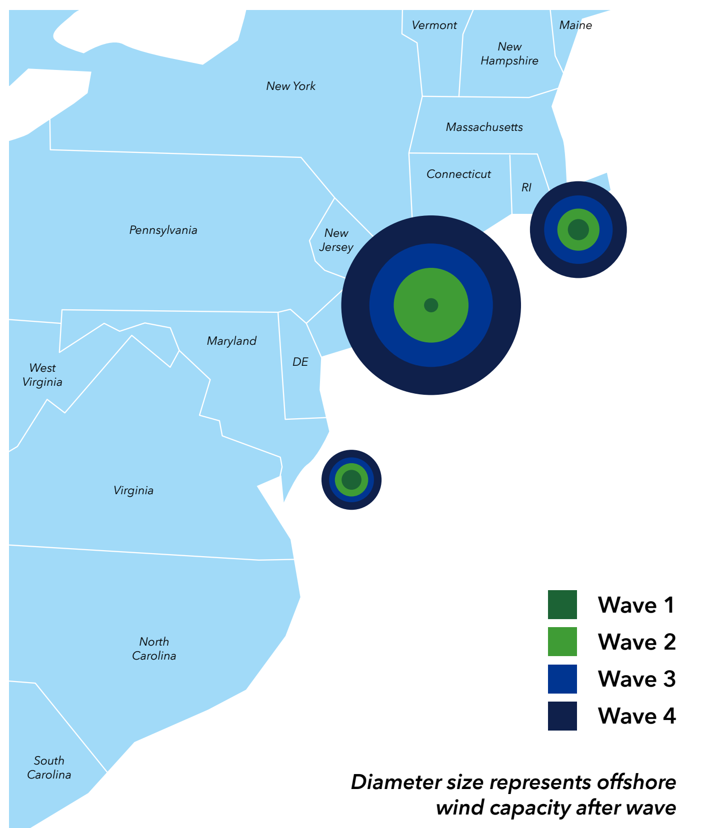
	Power offtake	Federal COP	Commercial Operations Date	Capacity (GW)
First Wave (In construction)	Secured	Approved	By end 2027	6.0
Second Wave	Expected by end 2026	Expected by end 2025	2028-2030	10.6
Third Wave	Expected by end 2028	Not submitted and/or approval 2026 or later	2031-2033	12.0
Fourth Wave	Expected by end 2030	Not submitted	2034-2036	14.4
				42.0 TOTAL

Projects within the later waves contain higher uncertainty around specific commercial operation dates given the limited information or confidence in their development cycles, and undetermined paths to secure offtake given project geography. The waves are used for reporting purposes, grouping together projects with similar maturity. While it is expected that the actual buildout of later waves will differ more from the assumptions used in this study, the overall conclusions of the study should remain relevant.

2.3 Cost model

Using the project buildout forecast sorted into waves as described above, the cost model estimates future expected capacity-weighted average LCOE for each wave. This value is derived from individual project-specific financial pro formas created for each of the 34 individual projects, modelled using site-specific design parameters and standard financial model methodologies.

FIGURE 2.2 REGIONAL DISTRIBUTION OF PROJECT WAVES AND CAPACITY



The impacts of the Investments are applied to the project-specific CAPEX, DEVEX, or OPEX inputs as relevant, allowing for visualization of the long-term effects of each on individual project and wave-level LCOE. The Investments were applied to project inputs on a case-by-case basis, resulting in variable impacts between projects. For example, a project within close range of an upgraded port will benefit from this proximity through a commensurate reduction in port upgrade cost inputs (a CAPEX element), while a project that is geographically more distant may see no reduction to cost inputs in relation to this port upgrade. Care is also taken to ensure that multiple projects are not benefitting from the same investment at the same time.

All results are presented in 2024 dollars.

2.3.1 Project inputs

Project parameters: Technical parameters for each project were determined to model costs. The key parameters which influence the model are:

- Final investment decision (FID) date
- Commercial operation date (COD)
- Number of turbines
- Distance from point of interconnection (POI)
- Water depth
- Distance from O&M port
- Number of export cables
- Transmission type (HVAC vs. HVDC)
- Number of offshore substations
- Net energy production

CAPEX inputs: Modelling of project CAPEX was undertaken using the technical project parameters and representative unit costs from DNV's database of observed project costs and supplier quotes. The CAPEX value includes costs for supply and installation of turbines, foundations, inter-array cables, export cables, offshore substations, onshore substations, and interconnection. An offshore wind project includes numerous additional activities, services, and components, which are part of the overall CAPEX obligations of the developer. These costs were considered by DNV as part of the major categories of CAPEX listed above. For example, secondary steel costs for monopile platforms and ladders are included in the foundation supply category.

DEVEX inputs: Modelling of project DEVEX was static and based on a cost breakdown for site characterization and surveys, tendering, package engineering and management, environmental studies and permitting, and other non-technical categories including legal support, insurance, and stakeholder engagement. DEVEX was not assumed to vary significantly between projects as DEVEX does not typically scale directly with project capacity. Given that DEVEX has a relatively small impact on LCOE, refining the methodology to yield a more accurate site-specific DEVEX estimation does not impact overall results.

OPEX inputs: Modelling of project OPEX took a hybrid approach, with some costs dynamically scaled with project parameters and some costs fixed, based on DNV's database of observed OPEX cost models, supplier quotes, and publicly available information. The OPEX calculations consider O&M onshore staff, offshore staff, ports and warehouses, vessels, turbine and balance of plant service and maintenance agreements, major component replacement, owner's costs, engineering and contingency. Since OPEX is necessary throughout the operational lifecycle of a project, the OPEX cost was applied in the LCOE equation at the time of expected project COD, with costs escalating on an annual basis in line with conventional project pro forma methodology for an assumed operational lifetime of 30 years.

2.3.2 Macroeconomic inputs

Inflation assumptions: Inflation has been one of the predominant drivers of the observed increase in offshore wind CAPEX cost in recent years. The inflation assumptions considered in DNV's model are consistent with the Bureau of Labor Statistics CPI-U index. Inflation rates were applied to unit costs from DNV's database of observed project costs and supplier quotes to derive a set of CAPEX unit costs in 2024 dollars. These 2024 unit costs were then applied to all 34 projects regardless of COD

WACC calculations: Weighted average cost of capital (WACC) represents a company's average cost of capital from all sources. For this study, DNV assumed the total capital required for each project would be provided according to a fixed debt-to-equity ratio, with the WACC rate applied to the debt portion.

The values observed for WACC have risen dramatically during recent years but are predicted to decline gradually over the next five years as interest rates fall, the market matures, and investor confidence grows. Subsequently, projects in the third and fourth waves will benefit the most from the lower WACC rates predicted for the future.

Due to uncertainty around the future of WACC rates, three scenarios were considered for the study representing low-, mid- and high-WACC forecast curves. The WACC forecast was provided by Energy and Environmental Economics (E3), a leading firm in this field. The bulk of the results presented herein are based on the mid-range WACC curve assumption, although conclusions related to the low- and high-WACC curve assumptions are also discussed. The key assumptions inherent in the mid-range WACC curve assumptions are shown in Table 2.1 below.

TABLE 1.1 WEIGHTED AVERAGE COST OF CAPITAL ASSUMPTIONS, PROVIDED BY E3

	Effective Tax Rate	Debt fraction	WACC Rate
Low-WACC curve	27%	70.3%	7.59% (2024) to 7.06% (2026 – 2036)
Mid-WACC curve	**27%**	**61.5%**	**9.05% (2024) to 8.45% (2027 – 2036)**
High-WACC curve	27%	50.7%	10.15% (2024) to 8.96% (2029 – 2036)

Debt financing is typically secured well in advance of COD. As such, the WACC rate applied to each project is set multiple years prior to COD. For example, a project with expected COD in 2030 may receive the WACC rate forecast for 2026. For projects in the First Wave, financial close dates are largely known and the corresponding WACC rate is applied. In the absence of a known project specific date, DNV has assumed a fixed gap between financial close and COD. Due to the recent WACC spike, the greatest (negative) impact is on projects with a COD between 2027 and 2029. These are projects which are securing debt financing when WACC is at a forecasted peak.

1.3.3 LCOE calculation and results

By applying the cost model methodology described above, without consideration for the Investments, LCOE values for each wave are estimated. DNV then calculated the impact of each individual investment on LCOE in each wave, with the difference in LCOE results representing the overall positive impact of each investment initiative.

There are different calculation methods for LCOE, some more complex than others. Given the goal of this study is to estimate Investment impact, DNV calculated LCOE using the more simplistic calculation method of:

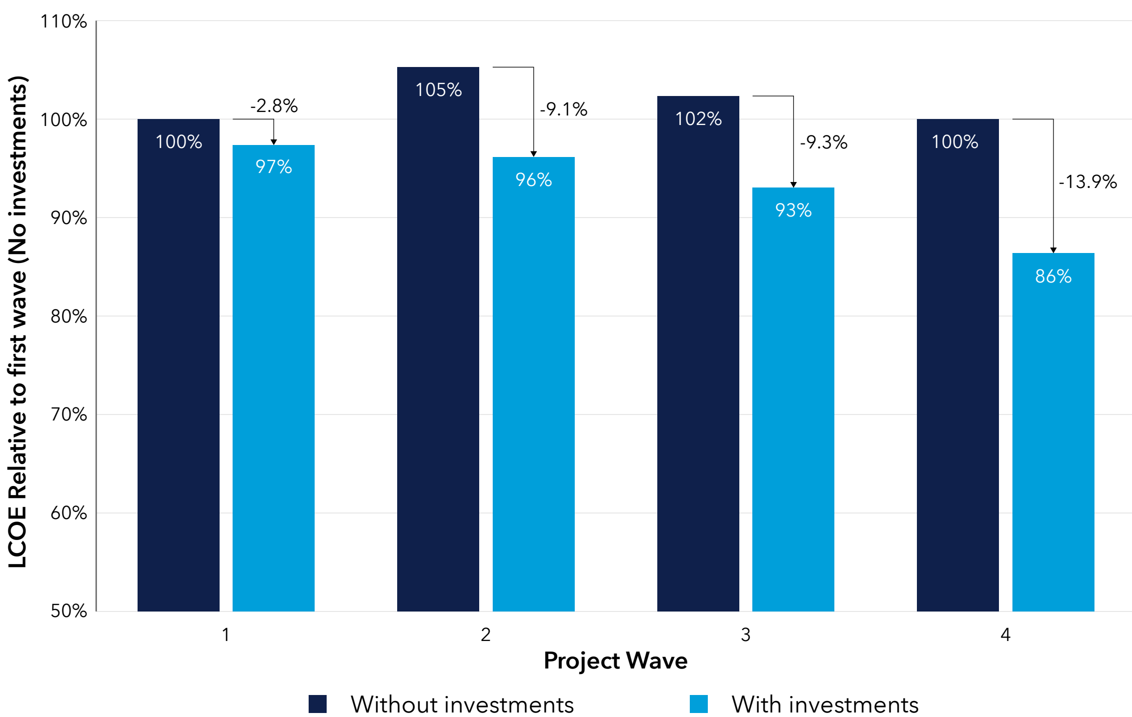
$$\frac{\Sigma\ [\ (CAPEX_t + DEVEX_t + OPEX_t) \times (1 + WACC)^{-t}\ ]}{\Sigma\ \text{Annual Energy Production} \times (1 + WACC)^{-t}}$$

The intent of the LCOE calculation method used was to derive the representative minimum value by which a given project could remain financially viable. By comparing the first set of LCOE values (without the Investments) to the second set of LCOE values (with Investments), long-term conclusions could be drawn on the cumulative effects of Investments on specific project waves. Selected results are presented in detail in the following section.

3. Findings

The results of the study were aggregated, using a capacity-weighted average, into the waves described in Section 2.2. Results are shown in Figure 3 1 below, with the blue-shaded bars representing relative LCOE forecasted without consideration of any investment initiatives (a fictional case), and the green-shaded bars representing relative LCOE forecasted with consideration for the Investments being made.

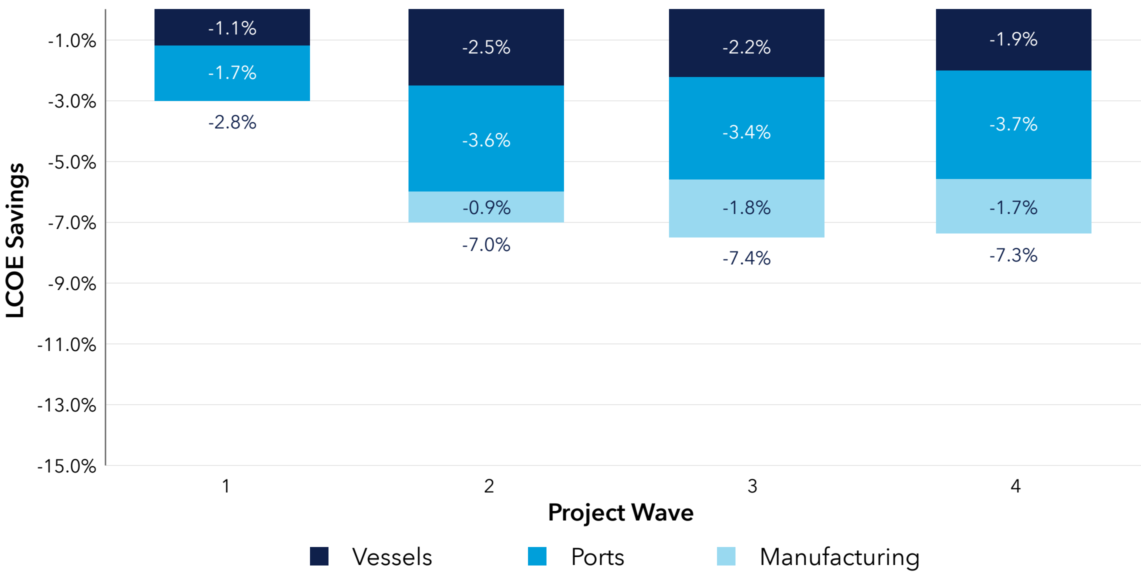
FIGURE 3.1 RELATIVE CHANGE IN LCOE PER WAVE WITH AND WITHOUT INVESTMENT IMPACTS[1]



In Figure 3.2 below, we see the isolated impacts of vessels, ports, and manufacturing investments, with a breakdown per Investment type within each wave. The variations in the magnitude of impact by Investment type within each wave illustrates how certain types have a more immediate impact (vessels and ports), while others require a longer lead time to yield significant impact (manufacturing).

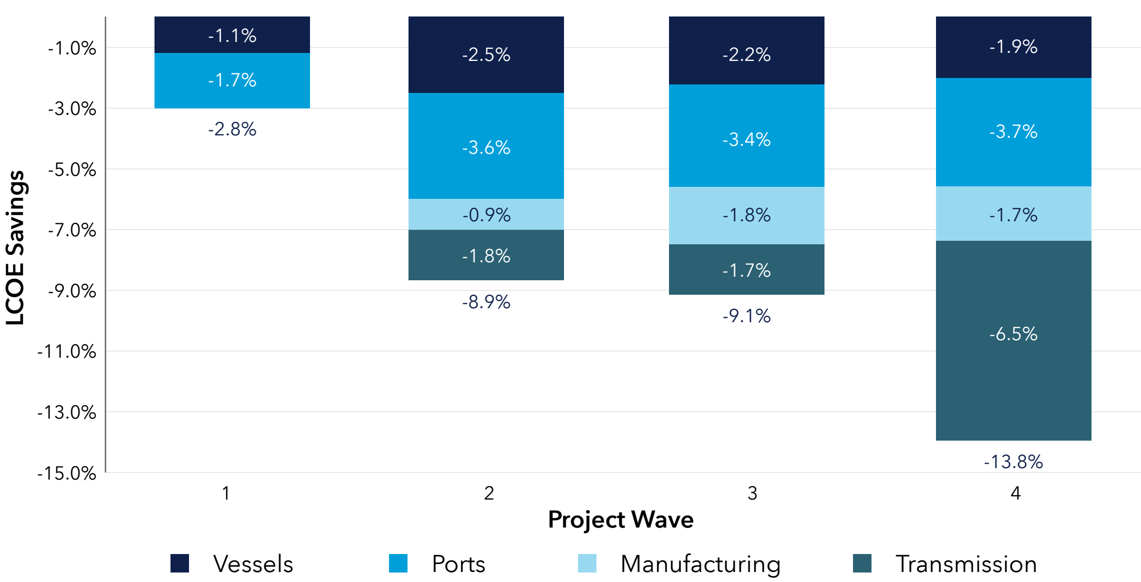
1. Mid WACC Curve Assumptions

FIGURE 3.2 WEIGHTED AVERAGE LCOE IMPACT PER WAVE AS A RESULT OF VESSELS, PORTS, AND MANUFACTURING INVESTMENTS[2]



Transmission related initiatives were also considered, although their cost benefits to new projects are exhausted over time (see Section 2.1). This makes the transmission investments different than those outlined above, but no less impactful. Figure 3.3 shows the additional LCOE benefits realized per wave due to transmission Investments.

FIGURE 3.3 WEIGHTED AVERAGE LCOE IMPACT PER WAVE AS A RESULT OF TRANSMISSION INVESTMENTS[2]



2. Mid WACC Curve Assumptions

Table 3.1 presents the impact of each initiative category on a per-wave basis converted to CAPEX and/or DEVEX savings. Table 3.2 presents the impact of each initiative category on a per-wave basis converted to OPEX savings, assuming a 30 year operational lifetime.

TABLE 3.1 ESTIMATED SAVINGS IN CAPEX OR DEVEX IN 2024 U.S. DOLLARS

	Wave 1	Wave 2	Wave 3	Wave 4	Total
Vessels	$350m	$750m	$950m	$850m	$2,900m
Ports	$400m	$1,100m	$1,150m	$1,400m	$4,050m
Manufacturing	No Savings	$400m	$1,000m	$1,100m	$2,500m
Transmission	No Savings	$800m	$950m	$4,100m	$5,850m
Total	**$750m**	**$3,050m**	**$4,050m**	**$7,450m**	**$15,300m**

TABLE 3.2 ESTIMATED LIFETIME SAVINGS IN OPEX IN 2024 U.S. DOLLARS

	Wave 1	Wave 2	Wave 3	Wave 4	Total
Vessels	Negligible	$930m	$660m	$660m	$2,250m
Ports	$300m	$1,410m	$1,890m	$1,890m	$5,490m
Total	**$300m**	**$2,340m**	**$2,550m**	**$2,550m**	**$7,740m**

4. Conclusions

The U.S. offshore wind sector is on the verge of transformative growth, and the early investments being made today are already shaping a future filled with economic and environmental benefits. As we look at the implications of these Investments, it is evident that they are driving significant cost reductions. Based on the results of the modeling, conclusions from the study are summarized below:

[1] Without the Investments being made by U.S. states, the federal government, and private sector, there would not be significant reduction in offshore wind LCOE for at least 15 years. With the Investments, we see LCOEs drop immediately and consistently after the first wave, reaching a 14% reduction for the fourth wave as compared to the first wave.

[2] Due to the 23 Investments qualified for the study, $15.3 billion in CAPEX or DEVEX is expected to be avoided through 2036. Taking into consideration 30 years of expected project operation, the Investments are expected to save the offshore wind industry an additional $7.7 billion in OPEX.

[3] The vast majority of vessel and port investments have been planned in coordination with First Wave projects. While the First Wave does see moderate LCOE reduction (approximately 3%), the positive LCOE benefits from newly built vessels and port upgrades more than doubles for the Second Wave (to approximately 6%). This relatively high positive impact continues into the Third Wave and Fourth Wave and could be assumed to continue in perpetuity.

[4] Given the long schedules required to bring new manufacturing facilities online, first wave projects do not see a material LCOE benefit from manufacturing investments. Second wave projects realize a moderate benefit (approximately 1% reduction), which increases for the third and fourth waves. In comparison to vessel and port investments, the cost benefits from manufacturing initiatives are realized further into the future, but could also be assumed to continue in perpetuity.

[5] The cost benefits from transmission investments are substantial, and overall have the greatest LCOE impact as compared to the other investment categories. However, the transmission investments considered for this study are expected to be "used up" by the end of the fourth wave. Thus, additional transmission investments would be required to see benefits extend into a fifth or sixth wave of offshore projects, which is different than the more evergreen benefits of vessel, port, and manufacturing investments.

[6] While not presented here, DNV evaluated results using both the low- and high-WACC scenarios as well. Given the capital-intensive nature of offshore wind projects, even small differences in WACC have large impacts on LCOE, although not on the estimation of Investment impact. Any reduction in WACC that can be achieved in future would result in considerable cost benefits to the industry.

5. Key Implications

In the coming decade, the U.S. is expected to avoid an estimated $23 billion in future offshore wind project costs due to the strategic investments being already made in supply chain infrastructure. This cost avoidance has been enabled largely by the first wave of offshore wind projects under construction, with long-term economic benefits expected to extend across future waves.

While it is not the purpose or intention of this study to provide a forecast of future offshore wind costs, it shows that LCOE for future projects could be significantly reduced by up to 14%, with 7.3% attributed to supply chain investments and 6.5% to non-project specific transmission investments. These estimates are based on conservative assumptions and pipeline modeling, focusing only on current investments. Other external sources of potential cost reduction such as cost of capital, technological advancements, supply chain maturation, and increased construction efficiency were also not included, suggesting potential for further savings.

Although these cost reductions are encouraging, this analysis does not serve as a blueprint for prioritizing future investments. The impact of individual supply chain and infrastructure investments varies, and the study recommends leveraging lessons learned to maximize future investments.

This study underscores the critical value of early strategic investments in offshore wind infrastructure and domestic supply chains, which are already driving significant cost reductions. These investments lay the foundation for long-term success of the U.S. offshore wind industry. The $23 billion in future cost savings is just the beginning as the offshore wind industry scales in America.

6. Acknowledgements

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