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Maryland offshore wind: port assessment

Operations, maintenance and service

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Document history

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BVG Associates

BVG Associates is a technical consultancy with expertise in wind and marine energy technologies. The team probably has the best independent knowledge of the supply chain and market for wind turbines in the UK. BVG Associates has over 150 man years experience in the wind industry, many of these being “hands on” with wind turbine manufacturers, leading RD&D, purchasing and production departments. BVG Associates has consistently delivered to customers in many areas of the wind energy sector, including:

- Market leaders and new entrants in wind turbine supply and UK and EU wind farm development
- Market leaders and new entrants in wind farm component design and supply
- New and established players within the wind industry of all sizes, in the UK and on most continents, and
- Department of Energy and Climate Change (DECC), RenewableUK, The Crown Estate, the Energy Technologies Institute, the Carbon Trust, Scottish Enterprise and other similar enabling bodies.

The views expressed in this report are those of BVG Associates. The content of this report does not necessarily reflect the views of the Maryland Energy Administration. Front cover image “Crew transfer to Lynn & Inner Dowsing” courtesy of Centrica Energy.

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Executive summary

This report has been commissioned by the Maryland Energy Administration (MEA) to investigate what port infrastructure will be required during the long term operation, maintenance and servicing (OMS) of offshore wind projects in the Maryland Wind Energy Area (WEA) and along the mid-Atlantic region.

OMS activities for an offshore wind farm

A baseline scenario was developed with an offshore wind farm with a total capacity of 252MW, 42 6MW turbines and an operational life of 25 years. The center of the wind farm is located approximately 15 nautical miles (nm) (17 statute miles or 28km) from a 'base port' with the marine and land infrastructure required to support the OMS activity of the project.

The distance from the base port to the wind farm in the baseline scenario means a 'port-based' transportation strategy would most likely be used with small, fast personnel transfer vessels (PTVs). The project owner may also chose to supplement this approach with helicopter support to minimize the time when weather and sea conditions mean it is not possible to reach the wind farm by water.

For the baseline scenario (252MW), it is estimated that a minimum of three PTVs and would be required. This may be increased to four PTVs if the responsible party wants to ensure it has enough PTVs available in the case of a vessel breakdown or scheduled maintenance.

If the offshore wind farm is located more than 30nm from its base port, it is likely that an alternative 'offshore-based' strategy is used involving service operation vessels (SOVs) which can remain offshore for sustained periods of time.

Infrastructure of an offshore wind farm

Under the baseline scenario, approximately 170ft (50m) of quayside or pontoon frontage is estimated to be required to accommodate a fleet of three PTVs. Assuming the use of standard PTVs, a minimum water depth of 8ft (2.5m) at the quayside and in the channel will also be required. The responsive nature of unplanned service activity on an offshore wind farm means that it is important that vessels can leave the base port in any state of the tide. Pontoon infrastructure of this sort is expected to require an estimated investment of between $450,000 to $600,000.

A site with a footprint of between 22,000 sq ft to 33,000 sq ft (2,000m^2 to 3,000m^2) is needed to accommodate the offices, warehousing and working areas required. A parking area for staff will also be required, although this may be located remotely with staff shuttled to the site if space is at a premium. Investment for this level of infrastructure is anticipated to be approximately $5 million.

A helibase is likely to need a site up to approximately 5,000m^2.

Regional requirements of an offshore wind farm OMS facility

Such an OMS facility is expected to employ between 15 and 20 members of onshore staff and approximately 40 offshore staff. This core staff is likely to be supplemented with temporary contractors during planned maintenance campaigns in the summer and a range of specialists to address specific issues.

The operation of the base port will also require a range of services to be available in the local economy, including hotels or suitable rental properties, suppliers of generic spare components and consumables, trade services and training facilities.

State-level site assessment

A review of port capacity in Maryland and its neighboring states identified two port sites with the appropriate infrastructure to accommodate a port-based strategy (Ocean City (MD) and Indian River Inlet (DE)) and two port sites with the appropriate infrastructure to accommodate an offshore-based strategy (Baltimore (MD) and the port cluster around Hampton Roads (VA)).

Cost modeling suggests that a port-based strategy operating out of Ocean City with helicopter support is likely to be the most cost effective option. It is noted, however, that the cost difference with Indian River Inlet is marginal and other non-cost factors are also likely to play an important role in the developer's final decision.

Ocean City region site assessment

Three potential sites have been identified in the Ocean City region:

A. West Ocean City Harbor (Harbor Road)

B. The Cropper Concrete site, and

C. The Ocean City Municipal Airport.

A fourth option was also considered in which the main offices and warehouses are located at the airport and a smaller 'technicians terminal' is located at either (A) or (B).

In each case, detail planning work is still required to confirm the capability of the site to accommodate an OMS facility and engage with local residential and business communities to identify and resolve issues that could delay or prevent progress

Figure 1 Locations identified as potential sites for an OMS base port in Ocean City/Worcester County. Image courtesy of Google Maps.

Next steps for Ocean City and Worcester County

The completion of the first Maryland offshore wind farm may still be some years away but there are many actions that stakeholders and the business community in Ocean City and Worcester County could be taking to proactively secure their region as the location of the OMS base and to maximize the economic impact. The blueprint of suggested actions can be found in Section 9.2.

In particular, it is important that a collaborative ‘delivery group’ is established that involves state, regional and local authorities, public enabling bodies and US Wind Inc.

This group will be able to coordinate decisions and deliver actions that will help the region secure the OMS base and maximize its long term economic impact.

1. Introduction

The state of Maryland is in the process of developing offshore wind capacity in the waters off its coast. This has already involved the establishment of an 80,000 acre zone, called the 'Wind Energy Area' (WEA) and, in August 2014, the rights to develop this WEA were bought by a developer, US Wind Inc.

This report has been commissioned by the Maryland Energy Administration (MEA) to investigate what port infrastructure will be required during the long term operation, maintenance and servicing (OMS) of offshore wind projects in the Maryland WEA, and along the mid-Atlantic region.

This report will cover:

- The OMS activities and strategies that are likely to be involved in an initial Maryland offshore wind farm
- The port infrastructure that will be required to support these activities, including land, buildings, quayside and vessel access channels
- The direct and indirect workforce that will be generated and the types of skills and supply chain that will be required
- The parties involved in OMS activity and the typical allocation of responsibilities
- The changes in requirements for infrastructure and workforce that would be caused by changes in the baseline assumptions about the proposed Maryland wind farm
- A port assessment considering sites in the mid-Atlantic region that could feasibly serve as an OMS base for projects in the Maryland WEA
- A cost analysis of four key sites identified as potential candidates to host an OMS base
- A detailed port assessment of site options in Ocean City and West Ocean City, and
- A year-by-year guide for the actions that the offshore wind developer is likely to take regarding OMS activities, and the steps that the public and private sectors in Ocean City and Worcester County need to take to secure the OMS base.

2. OMS activities for an offshore wind farm

This section set outs the expected OMS activities that will be required to support the Maryland offshore wind farm.

This activity is based on a baseline scenario that involves an offshore wind farm with a total capacity of 252MW with 42 6MW turbines with an operational life of 25 years. After 25 years, it will be possible for the owner to repower the site by replacing the turbines but this has not been considered in this report.

The center of the wind farm is located approximately 15 nautical miles (nm) (17 statute miles or 28km) from a suitable 'base port' for OMS. This base port has the marine and land infrastructure required to support the OMS activity of the project.

2.1. Offshore activities

All the offshore activity that will be conducted from the base port can be categorized as either planned maintenance or unplanned service. Unplanned service can be split into minor and major activities depending on the size of components being handled.

It should also be noted that during the installation of the project, there is also a requirement for crew and technicians to be transported offshore as well as a range of small parts, tools and consumables. There is also a need for guard vessel to ensure other sea traffic does not enter the construction zone. Such activities have similar infrastructure requirements to those described below and may be carried out from the same facility.

Planned maintenance

Planned maintenance is undertaken on a routine basis to inspect equipment, replace worn parts and replenish consumables.

The majority of activity in this element is focused on the turbine during an annual campaign that is typically undertaken across the whole wind farm during the summer when there are the calmest sea conditions and lowest wind speeds. This avoids weather delays and reduces the amount of revenue lost by stopping production. Each turbine is shut down and a team of technicians completes a series of scheduled activities. In time, condition-based maintenance strategies are more likely to be used but this will not significantly affect activities related to the base port.

Foundation and cable maintenance requires less intensive activity and may be done on a less frequent basis.

Unplanned minor service

This element involves addressing failures or warnings that have caused the turbine to shut down and which cannot be resolved remotely.

There is a strong strategic focus on fixing issues as quickly as possible to minimize downtime and lost revenue. This means that there is an emphasis on getting technicians to the wind farm as quickly as possible and then allowing them to safely access, fix and disembark the turbine.

A wind farm with the number of turbines being considered in the baseline scenario is likely to require technician teams to visit at least one turbine every day, with more intensive activity required when wind speeds and/or sea conditions restrict transportation offshore.

Unplanned major service

This element involves the replacement of large and heavy components that are worn or have failed. In particular, this will involve the replacement of blades, bearings (main, yaw and pitch), gearboxes and generators.

Such activities typically require the use of a jack-up vessel although the use of floating crane vessels with advanced dynamic positioning systems is also proposed. As this activity is not routine, the responsible party is unlikely to require dedicated facilities but will rent suitable port land and quayside when required. Typically, a number of these activities are undertaken in a campaign, rather than one-off interventions, due to high mobilization costs.

2.2. Onshore activities

Depending on the warranty and operation agreement, the operational control and management of the wind farm is typically split between the centralized control facility of the turbine supplier and a wind farm-specific management facility of the wind farm owner.

Centralized control facility

The turbine supplier's centralized control facility will be located away from the base port and will serve all of the projects that use the company's turbines within a wide geographic region. This facility may be located anywhere in the Mid-Atlantic area and have responsibility for offshore projects across the region.

A 24/7 team at this facility will interpret feedback from the turbine and wind farm supervisory control and data acquisition (SCADA) and condition monitoring systems to identify stopped turbines or those showing evidence of a risk of imminent or eventual failure. Initially, this information will be provided by the turbine supplier but responsibility may pass to another party at the end of the warranty period.

The turbine supplier or third party will have expert technicians available who can perform a risk assessed remote reset or give specific guidance to staff at the wind farm base port about what has occurred and what actions need to be taken to resolve the issue.

Wind farm-specific management facility

The planning of the offshore maintenance and service activities of the wind farm is likely to be undertaken at an office in the base port.

This involves preparing work plans and method statements for offshore activity, maintaining health and safety training of personnel, and ensuring staff, vessel and component availability.

This facility will also have a number of secure computer terminals to monitor some of the data from the wind farm and, depending on the approach of the responsible party, allow limited control of the turbines to facilitate safe technician access.

Wind farm visitor center

In some cases, the project owner may set up a visitor center so that the public can find out more about the wind farms and the technology that is involved.

Case study #1: offshore wind visitor centers

The Scroby Sands offshore wind farm is located in the North Sea off the east coast of the UK and was completed in 2004. It has a capacity of 60MW with 30 turbines. The developer, E.ON, has set up a visitor center in the nearby tourist resort of Great Yarmouth that attracts more than 35,000 visitors each year.

Figure 2 Scroby Sands visitor center

The visitor center is open during the summer and entry is free of charge. It has interactive educational games and models that explain how the wind farm works and how it was built.

2.3. Transportation strategy

The efficient transportation of technicians, tools and parts to the wind farm is critical if lost energy production is to be minimized.

The distance from the base port to the wind farm in the baseline scenario means a ‘port-based’ transportation strategy would most likely be used with small, fast personnel transfer vessels (PTVs).

The project owner may also chose to supplement this approach with helicopter support to minimize the time when weather and sea conditions mean it is not possible to reach the wind farm by water.

Marine transport

PTVs are typically constructed using composites or aluminum and use either jet or propeller propulsion. In Europe, they range in size and capacity but typically have a length of between 55ft and 85ft (17m and 26m) with a draft of between 4ft and 8ft (1.2m and 2.4m). Each vessel can carry approximately 12 technician plus tooling and small/medium sized spare components.

The practical working limit for these vessels is approximately 1.5m significant wave height. This is due to the need to transfer technicians safely to and from the turbine at the wind farm site.

For the baseline scenario (252MW), it is estimated that a minimum of three PTVs would be required. This may be increased to four PTVs if the responsible party wants to ensure it has enough PTVs available in the case of a breakdown or scheduled vessel maintenance.

The costs associated with this strategy are heavily affected by the distance between the base port and the wind farm site. This is because increasing distance adds fuel cost and reduces the available active working hours of technicians. It also means longer weather windows are required when planning trips.

Figure 3 Examples of personnel transfer vessels (PTVs) used in offshore wind.

Technicians work in teams of two or three for service activities with larger teams for maintenance. A PTV will take out one or more teams and deliver them to the target turbine(s). The PTV will then remain in the area until the technicians are ready to return to the base port.

During construction and maintenance or service campaigns, the PTVs may be supplemented by hotel ships which can stay offshore for sustained periods of time and maximize the working time of technicians by minimizing the distance and therefore the transit time to site. In Europe, these are typically converted ferry or cruise ships with accommodation for up to 120 people and areas that can be used for workshops and storage.

These hotel vessels typically have a length of between 400ft and 500ft (120m and 150m) with a draft of between 16ft and 20ft (5m and 6m).

For major service activity, the large deck space of the most modern jack-up vessels is not needed so the ships that are used have tended to be smaller, with a length of approximately 260ft (80m) and a draft of approximately 15ft (4.5m). The vessels have legs which, when raised, have an air draft of between 160ft and 250ft (50m and 75m)

Figure 4 Example of a hotel vessel used in offshore wind.

Helicopter transport

Challenging offshore conditions may mean it is not possible for a PTV to safely deliver technician teams by sea to a turbine. As such, the party responsible for service activities may choose to have a complementary helicopter transport strategy.

The use of helicopters to transport technicians and small components offshore has already been used on some European offshore wind projects and is expected to become more common in the future. The cost is substantial compared to PTVs and most mainstream turbine designs do not allow the helicopter to land so it must hover or return to shore once its passengers have disembarked. Helicopters do offer the benefit of being unaffected by the sea state and are significantly faster. The expense is also mitigated by the fact that the party responsible for offshore activities will need to have some provision for helicopter access anyway in case of emergencies.

Figure 5 Technician transfer to a turbine by helicopter.

In Europe, the majority of projects have used Airbus Helicopter (formerly Eurocopter) variants, such as the EC135 and EC145. These carry between three and nine technicians who are hoisted down onto a landing platform on the nacelle while the helicopter hovers above.

These helicopters cannot transport bulky or heavy components so are only used for unplanned service when it is not possible to use a PTV.

It is estimated that one helicopter would be required for the baseline scenario.

There is also a need for medical staff to be available that have been trained to be able to work from a helicopter in a marine environment.

3. Infrastructure of an offshore wind farm

This section describes the port infrastructure that would be needed to support the base port and transportation strategy described in Section 2.

3.1. Quayside

Most of the tooling, spare components and consumables used in planned maintenance and minor unplanned service activities are not particularly large or bulky. This means that most of the quayside or pontoon does not need high load-bearing capacity. The larger scale PTVs are able to carry containers up to 20ft (6m) in length to facilitate the loading of tools, components and consumables. In this case, quayside with a suitable load-bearing capacity and should allow the use of a crane or forklift truck.

Ideally, it will be possible to have enough quayside or pontoon frontage to accommodate all vessels at once but it is more likely that activity will be focus on a smaller number of berths and some PTVs will be loaded and dispatched in sequence. As such, approximately 170ft (50m) of quayside or pontoon frontage is estimated to be required to accommodate a fleet of three vessels. Loading limits are determined by the lifting capacity of the davit cranes on the turbines which typically have a limit of approximately two tonnes. Pontoon/quay frontage and cranage should be able to serve such requirements.

Industry feedback from port owners in the UK with similar pontoon infrastructure is that this level of suitable pontoon infrastructure would require an estimated investment of between $450,000 to $600,000.

For hotel vessels, the equivalent of a ferry dock with a link span and passenger loading facilities will be required.

For major unplanned service activities involving larger components, a stronger quayside will be required with a load-bearing capacity of at least 7 psi (five tonnes per square meter). This quayside would not be needed on a regular basis so it is likely the responsible party would rent space within an existing port when required. Regional spares strategies are not included in the scope of this study.

3.2. Vessel access

Assuming the use of standard PTVs, a minimum water depth of 8ft (2.5m) at the quayside and in the channel will be required. The responsive nature of unplanned service activity on an offshore wind farm means that it is important that vessels can leave the base port in any state of the tide.

Hotel vessels will require a water depth in the channel and at the quayside of up to 23ft (7m). If this is not available, it is also possible to load the vessel at a larger facility elsewhere and then transfer technicians and crews offshore from the base port.

A jack-up vessel will require a water depth in the channel and at the quayside of up to 20ft (6m). During transit, the vessels legs are raised so an air draft clearance of 50m to 100m will also be required.

3.3. Land area and buildings

A large inventory of tools, spare small components and consumables needs to be held at the base port to ensure that most commonly required items are available on demand to minimize downtime.

Warehousing is required with designated areas for chemical storage and climate controlled areas for sensitive components. A workshop is also needed to undertake minor repairs.

Components that would need a jack-up vessel to be installed are unlikely to be stored at the base port but will be held at a regional level by the turbine supplier (or third party providers) and dispatched to a suitable port as required.

Office buildings are needed for the wind farm-specific management facility, including meeting rooms, briefing rooms, and a control room equipped with sufficient computers (running a variety of specialist software) and monitors to enable all required functions of the onshore team to be performed. To facilitate data exchange with central data warehouses, the responsible party will specify a minimum internet connection and additional lines will be required for owner use. Welfare facilities for the technicians will also be needed including changing and shower rooms, a kitchen and a first aid facility.

In total, this onshore site is expected to have a total footprint of 22,000 sq ft to 33,000 sq ft (2,000m^2 to 3,000m^2) for the baseline scenario. A parking area for staff will also be required although this may be located remotely with staff shuttled to the site if space is at a premium.

The site will require electricity and water supply and sewerage to serve all of the buildings and road access suitable for heavy goods vehicles.

It will also be necessary for the port facility to have the capacity to store fuel and spare parts for the PTVs as well as boat maintenance facilities nearby with a suitable vessel crane or slipway.

Suitable disposal facilities will also be required for old parts and waste lubricants.

Cost of land side infrastructure

BVGA has generated an indicative estimate of the investment required for the infrastructure set out above.

These have been based on assumed requirements for the baseline wind farm of:

- Mooring for four PTVs
- A two-storey building for office-based activity and a control room
- An indoor workshop
- An outside laydown area, and
- A surfaced parking area

Costs are calculated using the Spons Civil Engineering and Highway Works Price Book 2013 (27th Edition). In the absence of any geotechnical information or existing building survey data, we have used the Spons "approximate estimating" methodology. These costs do not include:

- Permitting costs (such as planning applications)
- Professional fees for design and permitting
- Site investigation (including contaminated land surveys or geotechnical investigation)
- Any necessary remediation of contaminated land
- Any piling that may be required for foundations
- Provision of new utility services to buildings
- Disposal of waste materials
- Any land purchase costs, and
- Contingencies.

It has been assumed that the sites will be cleared and new buildings assembled rather than using any existing buildings.

As shown in Table 1, the CAPEX required for this level of onshore infrastructure is estimated to be almost $5 million. This level of investment is consistent with feedback from port owners in the UK that have developed similar OMS sites.

Table 1 Estimated cost of land and building CAPEX for baseline wind farm OMS base port.

Feature	Area (sq ft)	Cost estimate
Office/ control room	22,000	$4,260,000
Workshop area	5,000	$500,000
Laydown area	5,000	$80,000
Car parking area	11,000	$110,000
Total	**43,000**	**£4,950,000**

3.4. Helicopter base

If a combined PTV/helicopter strategy is used, it is possible to have either a helibase that is integrated into the main base port or located at a remote facility. A remote facility may either be standalone or part of an existing airfield.

Detailed requirements will be defined by the Federal Aviation Authority but an integrated or standalone helibase is likely to need a site up to approximately 54,000 sq ft (5,000m^2). This would include:

- A 65ft (20m) diameter helipad with suitable approach and arrival routes that are not obstructed by any buildings or trees
- A hangar with a footprint of 3,200 sq ft (300m^2) with component and tooling storage
- A wash-off area for the helicopter
- A 4,700 gallon (18,000 liter) secure fuel depot
- Wind sock and meteorological monitoring equipment for the local area, and
- Office buildings for passenger processing and desk-based activity.

Such a facility would need planning permits that would take account of the noise, flight path and environmental impact of ongoing activity.

This level of bespoke infrastructure would be significantly reduced if the operation was located at an existing helibase or airport. This is because the responsible party could take advantage of existing multiuser hangers and fuelling infrastructure. This benefit may be mitigated by the fact that flights may be more constrained from a shared facility.

The responsible party will be using the same technician teams whether using PTV or helicopter access, so it is important to ensure quick transfers between the base port and helibase are possible.

Case study #2: separate sites for the port and building

The Sheringham Shoal offshore wind farm is located in the North Sea off the east coast of England and was completed in 2012. It has a capacity of 317MW with 88 turbines.

Due to a lack of suitable ports along the nearby coastline, the developer constructed its own jetty near the town of Wells-next-the-Sea. The developer is using a port-based strategy.

Figure 6 The standalone jetty for the Sheringham Shoal wind farm.

The location of this jetty did not allow for the construction of adjacent onshore buildings so a remote facility was set up in Egmere which is approximately two miles south of Wells-next-the-Sea.

Figure 7 Artist impression of the offices and warehouses for the Sheringham Shoal wind farm.

Wind farm technicians start their shift at this inshore site every day where they prepare for their offshore duties. A mini-bus then transports them to the jetty where vessels take them offshore

Feedback from a company involved in this process has highlighted that this transport arrangement has caused some delays and a reduction in technician productivity. It was suggested that this would have been improved with a ‘technician terminal’ at the jetty at which staff could arrive, change and depart immediately.

4. Regional requirements of an offshore wind farm OMS facility

This section describes the requirements that will be needed to support the activities described in Section 2, including the labor force, local supply chain and transport links.

4.1. Workforce

The workforce that will support the ongoing operation, maintenance and service of the wind farm can be categorized as either 'direct' or 'indirect'.

Direct workforce

The direct workforce includes those people who are working exclusively for the wind farm on a full time basis.

It is expected that there will be between 15 and 20 members of staff involved in the planning and support of offshore activities who will be based permanently onshore at the base port.

This will include:

- A site manager who will oversee the running of all activities at the base port
- Marine coordinators who will liaise with port authorities and third-party providers of vessels to ensure availability of PTVs and qualified crew as well as monitoring offshore activities
- Warehouse staff who will maintain stock levels of tooling, spare parts and consumables and ensure their availability for technician teams
- Planners who will maintain work plans and manage the dispatch (and associated documentation) for technicians working on the wind farm
- A health and safety coordinator who will monitor work plans and method statements and arrange training for new and existing staff and subcontractors
- An administrative staff which will be responsible for technical, financial and legal requirements
- Owner representatives who will oversee the activities at the base and sign off work
- A vessel manager to ensure the PTVs are maintained and operational
- Control engineer(s) who will monitor data received from the wind farm, and
- Helibase staff who will undertake maintenance of the helicopter and process passengers before flights.

There will also be a staff of turbine technicians who will routinely visit the wind farm to undertake maintenance and service activity. The turbine technicians need a broad knowledge of electrical and mechanical engineering. They must also be prepared to work in confined spaces or at height for 12 hour shifts, usually four days on, four days off. There is extensive training required to understand how to maintain the turbine and technicians must also be certified for working offshore and at heights.

In the European market, suitable skills sets have been found in the offshore oil and gas sectors, the onshore wind sector and ex-military personnel. In most cases, turbine-specific training will be provided by the turbine supplier.

Assuming technicians are working 12 hour shifts on a 48 hour week, it is estimated that approximately 40 turbine technician staff will be required under the baseline scenario. This core staff is likely to be doubled with temporary contractors during the summer planned maintenance campaign.

Indirect work force

In addition to the permanent staff at the base port, the responsible party will also need to call upon a range of specialist technicians to address specific issues.

These will include:

- The visual inspection, cleaning and repair of blades by rope access teams
- High voltage specialists to undertake inspection and maintenance of the transmission equipment and cabling on the turbine and the offshore substation
- The inspection and repair of personnel access systems including lifts, fire system monitoring, fall arrest systems, davit cranes and the evacuation equipment
- The inspection and repair of the foundation and secondary steel, including the boat landing and ladders and gates and railings. Subsea work involves the use of divers or remotely operated vehicles (ROVs) and specialist contractors for repairing paintwork and cleaning marine growth and guano
- The monitoring of array and export cables to identify exposure from the seabed or damage. Again, subsea activity may involve the use of divers or ROVs
- The ongoing surveying of the site seabed and marine life to monitor the long term impact of the project, and
- Vessel repair and servicing for the PTVs and helicopters.

Some of these activities will be particularly specialized and require expertise from elsewhere in the USA or the world but it is likely that the project owner will wish to use local suppliers if they are available as this should ensure a rapid response and benefit from a greater knowledge of the wind farm and its environs.

4.2. Local supply chain

In addition to the particular infrastructure and skills requirements of the base port itself, the operation of the base port will also require a range of services to be available in the local economy.

This includes:

- Hotels or suitable rental properties in the area that can be used to accommodate subcontractors, in particular during peaks of activity
- Suppliers of generic spare components and consumables such as fasteners, lubricants and paints, tools and personal protective equipment
- Trade services including electricians, plumbers and cleaners, and
- Training facilities such as local colleges.

4.3. Transport links

Activity at the base port will involve calling on some specialist subcontractors at short notice as well as an ongoing need to replenish the inventory of components and consumables. It is therefore important to have good access to the highway network and international airports.

Case study #3: supporting the development of ports

Some developers of UK offshore wind projects have signed early-stage agreements with a number of local ports to help focus attention and encourage action.

In 2013, the developer of the 1,160MW Moray Firth project in Scotland signed memoranda of understanding with three ports in the Moray Firth. Feedback from the developer is that this process is intended to give the owners of these ports greater confidence in their prospects of being selected and will allow them to justify spending more development money. The agreements also have the benefit of increasing wider political and supply chain awareness.

It is also possible for developers to go further and proactively support the planning activities undertaken by the owners of potential sites.

In 2014, the developer of the 970MW Navitus Bay project off the south coast of England committed £100,000 ($166,000) to supporting the development of feasibility plans for its three shortlisted OMS candidate ports. This financial support is considered important as all the ports are relatively small without significant financial resources to pay for such investigations themselves.

5. Responsibility for OMS infrastructure and workforce

This section describes the parties involved in the OMS activities of an offshore wind farm and explains which are typically responsible for the development and long term maintenance and management of the infrastructure and workforce described in Sections 0 and 4.

5.1. The main parties

The main parties involved in the development and long term use of an OMS facility are typically:

- The developer: responsible for the construction of the wind farm, including the onshore and offshore elements
- The wind farm owner: responsible for the project once it has been fully commissioned. It is likely that the owner will initially be the developer but this company may choose to sell all, or part, of the project at some stage during the wind farm's life
- The turbine supplier, and
- Third party independent service providers (ISPs).

The developer and owner may be a single company or a consortium of companies with different levels of equity in the project

5.2. Allocation of responsibility

There is no set structure defining which party is responsible for particular actions. In the European market, different approaches have been used but it typically depends on the level of experience of the developer/owner and its portfolio of existing and anticipated projects in the region.

Typically, the developer is responsible for the selection of the base port location and for developing the physical infrastructure, including the building and quays/pontoons. In some cases, the capital investment in this infrastructure may be partially or fully taken on by the port owner which can then recoup this cost through rent and usage charges.

During the initial warranty period, the turbine supplier is responsible for the provision of maintenance and service technicians, spare parts and consumables for the turbines. The length of this period will be decided during the commercial negotiations as part of an overall turbine supply package and will depend on the preferences of the project developer. A typical warranty period will be between two and five years.

The project owner is typically responsible for the provision of the PTVs but will often charter them from a third party provider who will maintain the vessels and provide trained crews to operate the PTVs (not carry out work on the wind farm itself).

The project owner is also typically responsible for the maintenance and service of all non-turbine elements of the wind farm, including the foundations, cables, transmission infrastructure and ongoing surveys. This may involve recruiting permanent positions but it is more likely that the owner will use third party contractors as the work is not regular and often requires specialist skills or equipment.

At the end of the warranty period, the project owner can decide if it wishes to continue using the turbine supplier to provide technician operations management. If not, it has the choice of taking the activity in-house or sub-contracting the work to a third party provider. This transfer of responsibility may take place at other points during the lifetime of the project, depending on changes in the in-house capability of the project owner or the ownership of the project.

6. Variations in requirements

This section explains how changes in the baseline scenario will affect the strategy, infrastructure and regional requirements that have been set out in the sections above.

6.1. Impact of increased wind farm capacity

Change in scenario

The capacity of the wind farm being served by the base port increases from 252MW to 1,002MW with 167 6MW turbines.

It is assumed that all the turbines are from a single supplier.

Change in transportation strategy

The increase in turbine numbers requires an increase in the capacity of the base port but a port-based strategy using PTVs is still appropriate at this scale.

The number of PTVs required increases to between 12 and 14 and the number of helicopters increases to two.

Change in infrastructure

The length of quayside or pontoon frontage required increases to between 720ft and 980ft (220m and 300m), depending on the size of the vessels and the approach adopted by the responsible party for berthing and loading the PTVs.

The additional capacity required in office buildings and warehousing means the footprint of the site increases to between 43,000sq ft and 54,000sq ft (4,000m^2 and 5,000m^2) with additional space required for car parking.

Change in regional requirements

The size of the onshore staff supporting the wind farm increases to between approximately 35 and 40 while the turbine technician staff increases to approximately 160.

6.2. Impact of increased wind farm capacity and split sourcing

Change in scenario

The size of the project in the baseline scenario means it is unlikely that split sourcing of turbines would be considered but as project sizes increase, the option to use more than one turbine supplier is more feasible. This approach could increase OMS costs through duplication of effort but this should be compensated by the opportunity for the developer to drive down costs through competition.

In this variation, the capacity of the farm is increased to 1,002MW with 167 6MW turbines but, in contrast to the variation described in Section 6.1, the turbines are supplied by two different suppliers.

It is assumed that a ‘hands-off’ approach is adopted by the project owner so the turbine suppliers are responsible for most of the turbine service and maintenance activities. A more ‘hands-on’ approach by the developer may avoid some of the duplication identified below.

Change in transportation strategy

It is assumed that turbine suppliers are unwilling to share vessels as this may create scheduling and safety system conflicts, and uncontrolled operational risks. As such, it is assumed that the number of PTVs required increases by 15% from the variation described in Section 6.1 to 15 to16 to reflect the unwillingness to share redundant vessel capacity, requiring each operator to fully cover their redundancy requirements.

Change in infrastructure

Due to concerns about intellectual property associated with components and procedures, and insurance considerations, turbine suppliers in Europe have been unwilling to accept shared land-based facilities such as warehouses, offices and technician facilities.

As such, there is anticipated to be an increase in the land footprint of the total facility of approximately 15% from the variation described in Section 6.1 to reflect the required duplication of facilities.

There may also be an increase in the quay length required to accommodate the increased number of vessels used and the different loading patterns.

Change in regional requirements

The size of the onshore staff supporting the wind farms increases by approximately 30% to between 45 and 50 to account for the duplication in administrative and other onshore roles. Turbine technician staff numbers are expected to increase by 5% to approximately 170.

6.3. Impact on baseline of using larger turbines

Change in scenario

Rather than using 6MW turbines, the project is constructed using 25 wind turbines with a rated capacity of 10MW.

Turbines of this capacity are not currently available but suppliers such as Siemens Wind Power and MHI Vestas have indicated that they intend to develop 10MW turbines by the end of the decade and project economics point to further increases in turbine rating.

The cost benefits associated with the use of larger turbines is explored in Section 8.3.

Change in transportation strategy

Servicing and maintaining a larger turbine involves more work but the amount of work does not increase in direct proportion to the rated capacity. This means that a decrease in turbine numbers will result in less maintenance and service activity for the same size wind farm.

The change in turbine choice will not have any impact on the choice of transportation strategy, though the tendency may be to increased use of helicopters.

The number of PTVs needed to serve the project is reduced to two.

Change in infrastructure

The reduction in the number of PTVs required means that the minimum length of quayside or pontoon frontage is reduced to approximately 100ft (30m)

Change in regional requirements

The size of the onshore staff supporting the wind farm decreases to between eight and 12 members of staff while the turbine technician staff decreases to approximately 30.

6.4. Impact of increased distance to wind farm

Change in scenario

The location of the baseline project (with 6MW turbines) is changed so that it is now more than 30nm (35 statute miles or 55km) from a suitable base port.

Change in transportation strategy

The increase in distance means that the travel time to the wind farm from the base port using a PTV with an average speed of 20 knots is approximately 1.5 hours. This means that the total daily travel time to and from the project would account for at least a quarter of a technician's 12 hour shift which reduces their productivity.

The increased distance also means that a longer weather window is required to ensure the PTVs can get back to base safely which reduces the frequency with which technicians can travel to the site and increases the amount of turbine downtime expected.

These factors mean that project owners with so-called 'farshore' projects will usually use other strategies

The most likely alternative strategy is for the responsible party to use one or more Service Operation Vessels (SOVs) which can remain offshore for sustained periods of time. These vessels can be between 250ft and 300ft (75m to 90m) in length with a draft of up to 20ft (6m) and provide an offshore operation and accommodation base for up to 60 wind farm technicians and 20 crew members.

Figure 1 Artist impressions of proposed service operation vessels (SOVs) for offshore wind

Such vessels can operate for up to 45 days at the wind farm and longer if replenished at sea. They will be equipped with a heave-compensated turbine access platform and dynamic positioning (DP) systems to enable technicians to access turbines in a wider range of sea conditions than would be possible with PTVs. They may also support smaller 'daughter' PTVs, a helipad and ROVs.

Larger 'mothership' concepts are also being proposed that can support a small fleet of PTVs and a larger workforce of technicians although this approach is less mature.

The other option is for a developer is to use an offshore platform equipped with accommodation, workshops and storage to act as a harbor for PTVs. This option has been used on some European projects but it offers less operational flexibility than an SOV or mothership strategy.

The capital cost of SOVs plus the increased salary costs of maintaining staff offshore means these farshore strategies are currently more expensive than a conventional port-based strategy. This increased cost is partially offset by the fact that these vessels are stationed at the site and can work in more hostile sea conditions. This cuts the response time to unplanned outages and the amount lost energy production.

As the industry gains more experience in the use of SOVs and the technology improves, the cost gap between farshore- and port-based strategies may be reduced. This may mean that some projects closer than 30nm to a suitable port will also use SOVs or motherships but it is unlikely that these will ever replace port-based strategies entirely.

Change in infrastructure

Personnel, equipment and fuel can be delivered to SOVs in the field to allow them to remain offshore for sustained periods of time but it is still necessary to bring them back to a port on a regular basis. SOVs are likely to require ferry port-style facilities with cranes for loading containers and ramps for personnel.

It is likely that such vessels will need 23ft (7m) water depth alongside the quay and in the channel. As visits to port will be less frequent, 24/7 access is less critical than for a port-based strategy.

As most of the equipment storage, workshops and technician facilities will be on the vessel, a farshore-based strategy needs a smaller landside footprint. For the baseline scenario, it is estimated that a site of up to 11,000 sq ft (1,000m^2) will be required to provide car parking for technicians, overnight accommodation, and a logistics warehouse. The helicopter infrastructure would be unaffected.

Change in regional requirements

The change in working patterns required to support offshore shifts means it is expected that a farshore-based strategy will involve up to 50% more turbine technicians to provide full coverage, giving a total of approximately 60 technicians.

6.5. Summary of results

The assumptions about the land, quayside and personnel required under the baseline project and the variations described above are summarized in Table 2 below.

Table 2 Key characteristics of OMS base port under baseline scenario and variations.

Scenarios	Project capacity	Number of turbines	Distance from port	Land footprint required*	Quayside / pontoon length	Number of vessels	Direct onshore staff	Direct offshore staff
Baseline	252MW	42	< 30nm	22,000 – 33,000 sq ft	170ft	3 – 4 PTVs	15 – 20	40
Increased wind farm capacity	1,002MW	167	< 30nm	43,000 – 54,000 sq ft	720 – 980ft	12 – 14 PTVs	35 – 40	160
Increased wind farm capacity and split sourcing	1,002MW	167	< 30nm	50,000 – 62,000 sq ft	770 – 1,050ft	15 – 16 PTVs	45 – 50	170
Use of large turbines	250MW	25	< 30nm	22,000 – 33,000 sq ft	100 ft	2 PTVs	8 – 12	30
Increased distance to wind farm	252MW	42	>= 30nm	11,000 sq ft	260 – 300ft	1 SOV	15 – 20	60

*Excluding car parking and helibase

Case study #4: Site size and layout

The Rampion offshore wind project is being developed by E.ON and will involve the installation of between 100 and 175 turbine in the English Channel off the south coast of the UK. It is anticipated that E.ON will make a final investment decision on the project in 2015 with the start of onshore construction in the same year. In 2012, E.ON selected the port of Newhaven as its OMS base after a selection process involving a number of sites in the region. E.ON will be using a port-based strategy for their OMS activity.

The selected site is near the mouth of the River Ouse with easy access to the open sea and is less than 12nm (13.5 miles) from the center of the proposed wind farm site. The base will have 490ft (150m) of riverside pontoon frontage.

The proposed layout for E.ON's OMS base in shown in Figure 8. The total site is 140,000 sq ft and includes a warehouse with a footprint of 13,500 sq ft (1,250 m^2), a two-storey office that also has a footprint of 13,500 sq ft (1,250 m^2), 100 car spaces and oil storage and dumpster areas. The site currently has a number of rail sidings and old buildings that will be removed as part of the development.

Other benefits of the site include a turning and yard area for heavy goods vehicles (although E.ON confirms that most components are likely to be delivered by van) and two options for expanding the site if required.

The decision of E.ON to locate their OMS base in Newhaven has prompted a wider regeneration of the port, including the construction of new offices for the port authority and the development of a heavy lift quay.

Figure 8 Preliminary site layout of OMS base for Rampion wind farm (image courtesy of E.ON Climate and Renewables UK).

7. Site assessments

7.1. Methodology

Identifying sites

An assessment of ports in Maryland and its neighboring states has been undertaken to identify which sites could potentially be used as an OMS base port for a wind farm located in the Maryland WEA.

This involved reviewing a range of sources including Office of Coast Survey maritime charts, web-based map tools and the websites of port authorities. This process led to the identification of nine sites, of which four are located in Maryland. These sites can be seen in Figure 9

To compare the suitability of these sites, an assessment methodology has been developed based on the requirements set out in Section 3.

Assessment criteria: Transportation strategy

For each site, the distance is measured from the port to the center of the Maryland WEA to determine the likely transportation strategy that will be used. It is assumed that the selection of any site that is less than 30nm (35 statute miles) from the center of the WEA will allow the use of a port-based strategy using PTVs. The use of a site that is 30nm or more from the center of the WEA will require the use an offshore-based strategy with an SOV. No consideration is given to offshore-based strategies that use fixed offshore accommodation platforms or motherships as these are considered less likely to become mainstream solutions.

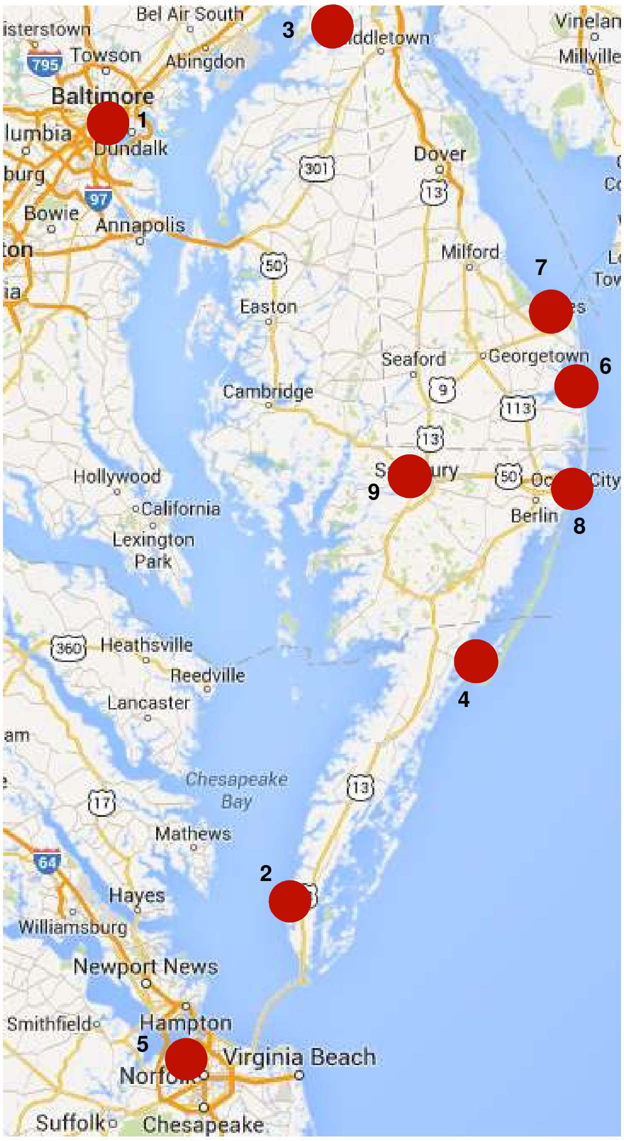
No consideration is given to the capability of ports to accommodate large jack-up vessels. This would be a benefit but it is assumed that the party responsible for major service activity will develop a separate port strategy for this work.

Assessment criteria: Vessel access

Once the transportation strategy is determined, the water depth in the main approach channel of the port is considered, as well as any air draft or beam limitations. This is to assess whether these would restrict the use of a PTV or SOV (depending on the strategy determined for the port).

Having existing suitable vessel access is a critical factor as dredging to increase the water depth could require a time-consuming and prolonged planning application and be an expensive and long term operation.

For a port-based strategy, it is assumed that a water depth of at least 8ft (2.5m) is required at all times. For an offshore-based strategy, the water depth required is at least 23ft (7m) but this is not needed at all times as it is possible to coordinate visits to the base port with high tides.



1	Baltimore (MD)
2	Cape Charles (VA)
3	Chesapeake City (MD)
4	Chincoteague Island (VA)
5	Hampton Roads (VA)
6	Indian River Inlet (DE)
7	Lewes (DE)
8	Ocean City (MD)
9	Salisbury (MD)

Figure 9 Locations identified as potential sites for an OMS base port for a wind farm in the Maryland WEA. Image courtesy of Google Maps.

If a port does not meet the vessel access requirement but could undertake reasonable, cost-effective actions to address the restriction, it is categorized as ‘marginal’.

Assessment criteria: Quayside and land

The quayside infrastructure and unoccupied land available are assessed to determine where buildings and warehouses might be located within the port. Consideration is also given to areas that are either sub-standard (and where reasonable investment could be made to meet requirements) or where there is an existing tenant that could be relocated.

In the case of a port-based strategy, a minimum of 170ft (50m) of quayside/pontoon frontage with a water depth of at least 8ft is required with a land area of 22,000 sq ft (2,000m^2). For an offshore-based strategy, the requirement is for 260ft (80m) of quayside with a minimum water depth of 23ft and a land area of 11,000 sq ft (1,000m^2).

When assessing sites, the proximity of the land area to the quayside is considered but is not included as a critical factor as it may be possible to use a split-site strategy if other characteristics of the port mean it is worthwhile.

Other notes

Other non-critical factors are also considered including the proximity of an airport or heli-base and other offshore wind projects to the site and the likely availability of a suitable workforce and supply chain.

7.2. Port profiles

Baltimore (Maryland)

Distance to Maryland WEA: 125nm (resulting in the selection of an offshore-based strategy to serve the WEA).

Vessel access: The shipping channels serving the port of Baltimore have water depths of 40ft to 50ft (12m to15m) so there would be no restrictions on the movements of SOVs. This would be the case with a route via the mouth of Chesapeake Bay or through the Chesapeake and Delaware Canal.

Verdict: Pass

Quayside and land: A number of sites, including the Dundalk Marine Terminal and Sparrows Point, have been identified as potential staging ports for the installation of a Maryland wind farm. These are all large, multi-user sites and the preparation of any of these sites for offshore wind installation activities could also include the development of a permanent OMS base port.

Verdict: Pass

Other notes: High demand for land means it is unlikely that a standalone helibase could be located in the port but there are a number of airports in the region including Baltimore/Washington International Airport and Martin State Airport which are 13 miles from the Seagirt Marine Terminal.

There is a large population within easy commuting distance of the site.

Cape Charles (Virginia)

Distance to Maryland WEA: 115nm (resulting in the selection of an offshore-based strategy to serve the WEA).

Vessel access: Maritime charts indicate that the channel to the port basin is dredged to approximately 10ft and the basin itself is dredged to 18ft at the deepest point.

Plans have been proposed to increase the water depth of the channel and basin to 22ft which would allow SOVs to enter the port on high tides. These plans were announced in 2011 as part of a scheme to produce concrete gravity base foundations for offshore wind turbines. It has been quoted that the scheme would cost approximately $10 million and work has not yet progressed.

Verdict: Marginal

Quayside and land: The main quayside on the southern side of the basin is currently used for the handling of aggregates and concrete structures so will have a high load bearing capacity. Other sites around the basin appear to be in a state of some disrepair but may also be available, subject to investment.

Verdict: Pass

Other notes: As the port is in a relatively low population area, sustaining a workforce is likely to be challenging. This is less of a problem than it would be with port-based strategy as it is more acceptable for personnel to have a longer, but less frequent, commute with an offshore-based strategy.

The nearest commercial airport to the site is the Norfolk International Airport which is 40 miles from the port by road. The size of the site, however, may mean that it is possible to develop an onsite heli-base if required.

Chesapeake City (Maryland)

Distance to Maryland WEA: 85nm (resulting in the selection of an offshore-based strategy to serve the WEA).

Vessel access: Maritime charts indicate that the berth is only dredged to 3ft. It is likely that this is based on outdated information and that it is deeper than this as there are pictures of vessels at the berth with drafts up to 13ft (4m). It is still likely, however, that the basin would require significant dredging to allow the use of an SOV.

Verdict: Marginal

Quayside and land: There is approximately 500ft of quayside available that appears to be able to handle multi-axle vehicles and containers.

The site and quayside is currently used by a towing company and although a shared arrangement may be possible, it may be challenging. Expansion may be possible but would involve the development of green field sites that are currently forested.

Verdict: Marginal

Other notes: The Cecil County Airport is approximately 10 miles from the site.

Although the local population is small, a base port here would be with commuting distance of Wilmington, Baltimore and even Philadelphia.

Chincoteague Island (Virginia)

Distance to Maryland WEA: 45nm (resulting in the selection of an offshore-based strategy to serve the WEA although it could be considered for port-based strategies with faster PTVs).

Vessel access: Maritime charts indicate that although the approach channel does exceed 23ft at points, there are parts that are less than 14ft.

Dredging may be undertaken to improve this situation, particularly around the Curtis Merritt Harbor at the southern end of the island, but it is not clear whether this would be possible due to seabed behavior in the channel or environmental zoning.

Verdict: Fail

Quayside and land: The main waterfront of the town is already occupied by commercial fishing vessels, private piers for leisure craft and a US Coast Guard base. As such, it is likely that a developer would face resistance to proposed industrial use.

There is land around the Curtis Merritt Harbor but it is unclear whether this could be brought into industrial use and road access is likely to be restricted.

Verdict: Marginal

Other notes: As the port is in a relatively low population area, sustaining a workforce is likely to be challenging. This is less of a problem than it would be with port-based strategy as it is more acceptable for personnel to have a longer, but less frequent, commute with an offshore-based strategy.

Wallops Flight Facility is located approximately 10 miles from the town but is a NASA rocket launch test facility and it is unlikely that it would consider allowing a helicopter operation that could compromise this use.

Hampton Roads (Virginia)

Distance to Maryland WEA: 106nm (resulting in the selection of an offshore-based strategy to serve WEA).

Vessel access: The shipping channels serving the port cluster around Hampton Roads have water depths of 40ft to 45ft (12m to 13.5m) so there would be no restrictions on the movements of SOVs.

Verdict: Pass

Quayside and land: There are six main port facilities around the harbor with a further six shipyards. All sites are assumed to have deep water quayside capacity.

It is likely that offshore wind activity would face competition for the use of quayside but the relative infrequency of port visits under an offshore-based strategy means activity could be accommodated relatively easily.

Verdict: Pass

Other notes: High demand for land means it is unlikely that a standalone helibase could be located in the port but there are a number of airports in the region, including Norfolk International Airport which is approximately 11 miles from the port of Norfolk.

There is likely to be a strong skills base in the area with the opportunity to recruit local military personnel.

Through the state of Virginia's own offshore wind programme, there appears to be a strong awareness of the potential opportunities of offshore wind in the supply chain and the port industry. This includes an ambition for capturing activity from neighboring states.

Indian River Inlet (Delaware)

Distance to Maryland WEA: 21nm (resulting in the selection of a port-based strategy to serve the WEA).

Vessel access: Maritime charts indicate that the water depths in the channel are at least 10ft with significantly deeper waters in parts. The bridge over the channel has a clearance of 45ft which would not cause any restrictions for a PTV.

Verdict: Pass

Quayside and land: On the north bank of the inlet is a large reclaimed land area that was developed to support the construction of the inlet bridge.

There is a US Coast Guard facility at the eastern end of this site with a small basin and two pontoons. It is unlikely that it will be possible to share this facility.

The remaining site is approximately 350,000sq ft with a compacted earth surface. As a former construction site, it is unlikely that obtaining planning consent for any offshore wind-related activity would be an issue.

There is currently only rock shielding on the waterside of the site and the speed of the current means it is unlikely that a river berth for PTVs could be built. As such, it is likely that a similar basin to that of the US Coast Guard would need to be cut into the site to provide the sheltered water required. While this would require some capital investment, it is unlikely to be difficult to achieve.

Verdict: Pass

Other notes: The nearest commercial airport to the site is the Ocean City Municipal airport which is 24 miles from the port by road. The size of the site and its relatively remote location may mean, however, that it is possible to develop an onsite heli-base if required.

The site is also the closest port to Delaware's own Wind Energy Area. This means it is within 30nm of both WEAs and may be considered as a combined hub for activity off the coast of both states.

Although the region can accommodate a large population during the summer, the permanent population level is low and is unlikely to have the relevant skills in place.

Lewes (Delaware)

Distance to Maryland WEA: 40nm (resulting in the selection of an offshore-based strategy to serve the WEA although it could be considered for port-based strategies with faster PTVs).

Vessel access: Maritime charts indicate that the Roosevelt inlet is shallow and suitable for small vessels only.

The water depth around the ferry terminal is more than 20ft but the main channel is only dredged to 15ft. As a maintained channel, it may be somewhat easier to increase this depth to allow its use by a SOV.

Verdict: Marginal

Quayside and land: To the western side of Roosevelt Inlet, there is some industrial waterside activity with pontoons but these are likely to only be suitable for small vessels.

Around the ferry terminal, there are five wooden piers but they are for leisure craft only and would not be suitable for an SOV. The land around the ferry terminal is largely occupied by buildings associated with the ferry, car parking and residential areas with no obvious plots available.

Verdict: Fail

Other notes: The nearest commercial airports to the site are Ocean City Municipal Airport and Wicomico Airport which are both 45 miles from the port by road.

Although the region can accommodate a large population during the summer, the permanent population level is low and is unlikely to have the relevant skills in place.

Ocean City (Maryland)

Distance to Maryland WEA: 16nm (resulting in the selection of a port-based strategy to serve the WEA).

Vessel access: Maritime charts indicate that the water depths in the channel to West Ocean City Harbor are at least 10ft so can accommodate PTVs without restrictions.

Maritime charts show the channel into Ocean City itself is only dredged to 6ft but it is reported that this is out of date and that the channel is more than 8ft. There is also a drawbridge bridge on this channel that has an air draft of 18ft when closed although it is opened on request during the winter and twice every hour during the summer.

Verdict: Pass

Quayside and land: There is a site in West Ocean City with an area of 30,000 sq ft and 630ft of quayside/pontoon frontage. There are also potential sites for expansion adjacent to this site.

There is also the site of a former concrete batching facility with an area of 150,000 sq ft in Ocean City upstream of the bridge. This site currently has no quayside available and is on the main channel so a river berth is not likely. This could be addressed by using the basin on the adjacent site or excavating a basin on the main site.

Verdict: Pass

Other notes: The nearest commercial airport to the site is Ocean City Municipal Airport which is two miles from the West Ocean City site by road and four miles from the Ocean City site. There are large areas of land available on the airport site with potential access to the water.

Although the region can accommodate a large population during the summer, the permanent population level is low and is unlikely to have the relevant skills in place.

The site is also the within 30nm of Delaware's Wind Energy Area. This means it is within 30nm of both WEAs and may be considered as a combined hub for activity off the coast of both states.

Salisbury (Maryland)

Distance to Maryland WEA: 205nm (resulting in the selection of an offshore-based strategy to serve the WEA).

Vessel access: The approach channel for Salisbury is maintained to 14ft so would not currently allow the use of a SOV. Ongoing river maintenance is contingent on sustaining traffic levels which have fallen in recent years. Efforts to develop new port capacity are in development but may not justify additional dredging beyond current limits.

Verdict: Fail

Quayside and land: The port operator, Wicomico County, is preparing plans for a new multi-user site with a land area of four million square feet. The site is currently undeveloped with no quayside, although infrastructure could potentially be put in place to meet the timescales of an offshore wind project.

Verdict: Marginal

Other notes: The nearest commercial airport to the site is Wicomico Airport which is eight miles from the port by road.

Salisbury may be able to provide support services to the primary OMS location with functions such as underwater export and array repair cables. Evaluation of support ports is outside the scope of this report.

7.3. Conclusion

As shown in Table 3, four of the nine original sites have passes in both criteria and are therefore considered well suited to hosting an OMS base port.

Table 3 Summary of site assessment

Site	Vessel access	Quayside and land
Baltimore (MD)	Pass	Pass
Cape Charles (VA)	Marginal	Pass
Chesapeake City (MD)	Marginal	Marginal
Chincoteague Island (VA)	Fail	Marginal
Hampton Roads (VA)	Pass	Pass
Indian River Inlet (DE)	Pass	Pass
Lewes (DE)	Marginal	Fail
Ocean City (MD)	Pass	Pass
Salisbury (MD)	Fail	Marginal

Of these viable sites, two are in Maryland (Baltimore and Ocean City) and there is one each in Delaware (Indian River Inlet) and Virginia (the port cluster around Hampton Roads).

Two of the sites, Ocean City and Indian River Inlet, are close enough to allow the use of port-based strategies for both the Maryland WEA and Delaware WEA. As such, there is the potential for either site to become a center of OMS activity in these two states.

The other two sites, Baltimore and Hampton Roads, are significantly further away from the Maryland WEA and could only be used with an offshore-based strategy. In both cases, however, there are advantages that may appeal to a developer. For example, it may be possible to achieve cost benefits by using infrastructure developed for offshore wind installation activities and to undertake major service activity from the same site. Both sites also have access to much larger workforces from which to recruit technicians and they both have excellent regional and international transport links. Finally, a base port in either of these large sites could potential become a center for OMS activities across the southern mid-Atlantic region by serving projects in Virginia and New Jersey as well as Maryland and Delaware.

8. Cost modeling of key sites

The site assessment in Section 7.3 identified Baltimore, Hampton Roads, Indian River Inlet and Ocean City as the most suitable locations for a potential OMS base port for the Maryland WEA. A modeling exercise has also been undertaken to investigate the potential costs of OMS from each of these sites.

The focus of this investigation has been on the Maryland WEA but the potential to serve projects in other states is considered in the sensitivity analysis below.

8.1. Baseline assumptions

This exercise has been undertaken using existing BVGA models that take into account a wide range of factors, including the distance of the wind farm from the base port, the use of helicopters and staff salary costs. These models are based on real-life industry data and previous outputs have been reviewed and verified through detailed industry engagement.

Importantly, the model does not only consider expenditure on personnel, infrastructure and equipment but also calculates the revenue that is lost when a turbine is not generating energy because of an equipment fault. This loss of revenue is the reason it is critical to keep mobilization and travel time low as it ensures that the overall mean time to repair (MTTR) is minimized.

Table 4 shows the base assumptions that are used in the model.

Table 4 Base assumptions for OMS cost model.

Assumption	Value
Wind farm rating	252MW
Wind turbine rating	6MW
Number of turbines	42
Annual mean wind speed	9.0 m/s
Annual mean wave height	1.0m
Technician cost (charge out)	$87/Hr
Capacity factor	48%
Generation tariff	$0.19/kWh
Crew transfer vessel cruise speed	20kts
Helicopter cruise speed	120kts

For locations where a port-based strategy is considered, two operating scenarios were considered:

- **Without helicopter:** Helicopter only used as a health and safety back-up for emergency situations.
- **With helicopter:** A helicopter is also available to transfer technicians and small parts to the wind farm, particularly during periods when metocean conditions prevent the use of PTVs.

For major service activity, it is assumed that a jack-up vessel will typically be mobilized twice a year to undertake repair and replacement campaigns. For Baltimore and Hampton Roads, the ports are assumed to be able to accommodate these vessels. As jack-up vessels cannot access either Ocean City or Indian River Inlet, it is assumed that major service activity is carried out from Baltimore.

Costs are stated in 2014 values and lifetime values without being discounted.

8.2. Results

The result of the modeling exercise for the four locations can be seen in Table 5.

Table 5 Modeled cost of OMS activities for key locations.

Location	Cost per year ($million)
Offshore-based strategies	
Baltimore (MD)	27.0
Hampton Roads (VA)	27.1
Port-based strategy without helicopter support	
Indian River Inlet (DE)	19.1
Ocean City (MD)	18.4
Port-based strategy with helicopter support	
Indian River Inlet (DE)	21.0
Ocean City (MD)	20.4

The costs for using the two locations associated with an offshore-based strategy is almost the same because the extra time (and hence cost) spent travelling the additional 20nm to Baltimore is marginal, as this journey is made infrequently.

The additional forecast cost associated with using an OMS base port in Baltimore or Hampton Roads is almost 50% more than the forecast cost for using a base port in Indian River Inlet or Ocean City. Under the baseline scenario, this difference is equivalent to a 25-year lifetime cost of almost $220 million.

The fact that there is only a small difference in the distance of Indian River Inlet and Ocean City from the WEA, means the cost difference between using these ports is also small. Assuming helicopter support is not used, the use of Ocean City offers a cost benefit of less than 4% in this modeling compared with Indian River Inlet. This cost benefit decreases to less than 3% if helicopter support is included. Under the baseline scenario, this is equivalent to a 25-year lifetime cost benefit of between $10 and $17 million.

8.3. Sensitivity analysis

As well as this baseline analysis, the impact of varying some of the underlying assumptions has also been modeled to reflect some of the factors that a developer may consider.

Salary costs

Given the relatively low population levels in the region surrounding Ocean City and Indian River Inlet, it is possible that the parties responsible for OMS activities may find it more difficult to recruit skilled staff.

As such, a variation has been prepared in which the salary costs for these location have been increased by 20% to reflect the challenge of attracting the right people to the area.

The results of this variation can be seen in Table 6. This shows that even with this increase, the impact on the cost of using a base port in Indian River Inlet Ocean City is an increase of approximately 2.0%. This small increase means that these locations are still more cost effective than those associated with offshore-based strategies.

Table 6 Modeled cost of OMS activities for key locations with 20% increase in salary cost.

Location	Cost per year ($million)
Port-based strategy without helicopter support	
Indian River Inlet (DE)	19.5
Ocean City (MD)	18.7
Port-based strategy with helicopter support	
Indian River Inlet (DE)	21.4
Ocean City (MD)	20.8

Turbine size

The impact of increasing the rated capacity of the turbines to 10MW (while keeping the overall project capacity the same) has also been considered.

The results of this variation can be seen in Table 7. This shows that the cost benefit associated with offshore-based strategies is a reduction of almost 12%, compared with port-based strategies with a cost benefit of 15%.

Despite this greater improvement in the economics for Baltimore or Hampton Roads, the additional costs associated with an offshore-based strategy remain almost 40% those of Indian River Inlet or Ocean City.

Table 7 Modeled cost of OMS activities for key locations with 10MW turbines.

Location	Cost per year ($million)
Offshore-based strategies	
Baltimore (MD)	23.8
Hampton Roads (VA)	23.9
Port-based strategy with helicopter support	
Indian River Inlet (DE)	18.0
Ocean City (MD)	17.3

Multiple wind farms

The proximity of Ocean City and Indian Inlet to the WEAs of both Maryland and Delaware means that there is the potential to cluster the base ports at one location.

To reflect this potential, the cost of providing OMS services to a 252MW project using 6MW turbines in the Delaware WEA has also been calculated for Indian River Inlet and Ocean City. In this case, Indian River Inlet is measured to be 17nm from the center of the Delaware WEA and Ocean City is 27nm from the center.

The combined costs of supporting both projects from either location are shown in Table 8. This shows that there is a cost benefit of almost 4% by locating the combined base ports in Indian River Inlet compared with Ocean City. This is equivalent to a 25-year lifetime cost benefit of $37.5 million.

This cost benefit depends on the relative size of the wind farms closest to each port location. As such, a larger wind farm in the Maryland WEA would change the overall cost benefit.

Table 8 Modeled cost of OMS activities for key locations serving a 252MW project in each of the Maryland and Delaware WEAs.

Location	Cost per year ($million)
Port-based strategy with helicopter support	
Indian River Inlet (DE)	37.8
Ocean City (MD)	39.3

9. Ocean City assessment

9.1. Background

A visit to Ocean City and Worcester County was conducted by BVGA between 17 and 19 June 2014. The purpose of the visit was to undertake an initial assessment of sites in the area that could accommodate an offshore wind OMS base.

This visit involved site tours as well as consultation with land owners, key members of the local business community, and officials from the engineering and economic development departments of both Ocean City and Worcester County. A list of all the stakeholders engaged with during this visit can be seen in Appendix 1.

Three potential sites have been identified:

D. West Ocean City Harbor (Harbor Road)

E. The Cropper Concrete site, and

F. Ocean City Municipal Airport.

A fourth option is also considered in which the main offices and warehouses are located at the airport and a smaller 'technicians terminal' is located at either (A) or (B).

For each site, information is presented on the main criteria defined in Section 3:

- Quayside and land
- Vessel access
- Land area and buildings, and
- Helicopter base.

In addition, we also consider:

- **Planning**: the planning designations applicable to the site and their relevance to an offshore wind OMS base port.
- **Potential for expansion**: the land and quayside available to increase the size of the port base to serve up to 1GW of offshore wind capacity.
- **Impact on existing businesses and local residents**: the likelihood of disrupting the local community and provoking opposition to the development.

We also include a SWOT analysis to summarize the strengths, weaknesses, opportunities and threats of each site. Each category is defined as follows:

- **Strengths**: existing characteristics of the site that give it an advantage over other sites.
- **Weaknesses**: existing characteristics of the site that put it at a disadvantage compared with other sites.
- **Opportunities**: chances to improve the performance or appeal of the site compared with other sites.
- **Threats**: risks that might reduce the performance or appeal of the site compared with other sites.

Figure 10 Locations identified as potential sites for an OMS base port in Ocean City/Worcester County. Image courtesy of Google Maps.

A. West Ocean City Harbor (Harbor Road)

Figure 11 West Ocean City Harbor (Harbor Road) site with main site (red), undeveloped residential site (orange) and Department of Natural Resources port site (yellow). Image courtesy of Google Maps.

This site is on the south side of the West Ocean City Harbor in Worcester County. The site was previously used for clam fishing and as a base for a marine contractor but was sold in late 2013. The current owner, Seaboard, acquired the site speculatively and does not currently have a specific use or tenant for it.

Quayside

Due to a lack of investment in the past, parts of the quayside infrastructure had become relatively degraded. This is currently being addressed by the new owners who are investing in improvements to the site.

The quay on the eastern end of the facility previously had a wooden bulkhead structure that had degraded, causing the land behind it to subside. The new owners have installed composite sheet piles to replace the old wooden structure that will resolve this issue. The central wooden pier in the basin has also been replaced with a new wooden pier.

The quay on the western end of the site has steel sheet piles that appear to be in good conditions.

Overall (including the wooden pier), the site has approximately 670ft (200m) of quayside available that will be able to accommodate the loading requirements.

Verdict: The site has an appropriate level of suitable quayside available in a sheltered harbor environment.

Land area and buildings

The site surface is a mix of concrete, tarmac and hard packed earth and has a land footprint of approximately 30,000 sq ft (2,800m^2).

At the eastern end of the site, there is an existing warehouse with a concrete floor and a footprint of approximately 3,700 sq ft (350m^2). The building appears to be structurally sound but is in a state of some disrepair. The owner of the site believes that the site would be suitable for a multiple-floor building.

On the western end of the site, there is a concrete ramp and platform that was used for loading pallets onto road vehicles. There is also a small fixed-position arm crane between this concrete platform and the quay but it is old and in a state of disrepair.

The site has electricity and water supply and establishing an internet connection is unlikely to be difficult because of the local infrastructure.

To the south of the site is a large, undeveloped area with a footprint of approximately 67,000 sq ft (6,300m^2) that is zoned for residential development. Feedback from local planners is that there would be strong local resistance to any proposed industrial activity but it could potentially be used for car parking (although there would be the threat that it could be developed into residential buildings at some point).

Verdict: The site has enough land to meet the baseline requirements for the main OMS buildings but not car parking (which could potentially be located on the vacant site to the south of the main site). The site is likely to be constrained if the developer wants to establish a particularly large warehouse or office facility or expand to provide OMS for a larger wind farm or multiple projects.

Vessel access

The new site owners report that the upgraded quay has been designed for a minimum dredged water depth of 10ft.

The outer channel is federally maintained and dredged by the US Army Corp of Engineers. The minimum mandated water depth for this channel is 10ft but it is reported that the last dredging operation actually increased the depth to 14ft. Some mild siltation occurs but the channel is dredged on an annual basis.

There is a six knot speed limit in the channel but the site is less than one nautical mile from the harbor entrance and the speed restriction is not considered a restriction for this location.

Verdict: Despite the speed restrictions in the harbor channel, the site has easy and quick access to the open sea. The water depth in the harbor and along the channel is sufficient for all current PTV designs.

Helicopter base

The site is in close proximity to a residential area so it is considered extremely unlikely that a helicopter base could be established there. In any case, there is also not enough land on the main site for such activity.

The site is 2.3 miles (3.7km) by good roads from Ocean City Municipal Airport which already has the infrastructure in place to be able to host a helibase.

Verdict: The proximity of the airport to the site is a positive advantage for the site.

Planning

This site has been zoned by Worcester County as ‘commercial / marine’ with the intention of protecting the local fishing and restaurant industries. There is uncertainty amongst local planning experts about whether this designation would include offshore wind OMS activity so this classification may need to be amended but this is not expected to be challenging.

Verdict: Obtaining planning permission is not expected to be a barrier to development.

Potential for expansion

As well as the vacant plot to the south of the site, there is the port facility of the Department of Natural Resources (DNR) police to the east of the main site with a footprint of 12,000 sq ft (1,100m^2). Subject to the interest of the DNR, the two sites could be combined and redeveloped to give a footprint that could meet the minimum land requirements for a 1GW offshore wind farm (excluding car parking).

Apart from this combination with the DNR site, which would offer an additional 130ft (40m), there are no options that have been identified for increasing quayside capacity for the site which is likely to be a constraint on expansion

Given any major expansion, it is likely that the Harbor Road could become severely congested unless suitable transport schemes were prepared to move personnel and equipment effectively.

Verdict: The limited land and quayside available is likely to be a constraint on any plans for major expansion of the site.

Impact on existing businesses and local residents

The harbor channel is currently heavily used by commercial fishing vessels and leisure (recreational fishing) craft. These two activities are relatively complementary as fishing vessels can time their movements to avoid period of high leisure activity. Offshore wind OMS traffic may be more problematic as the responsible party will want to respond to issues at the wind farm at short notice and this may coincide with peak leisure activity.

The designation of the harbor channel as federally maintained is currently based on the harbor maintaining a defined level of commercial fishing tonnage (the details of these targets were not available within the timescales of the preparation of this report). Local planners indicate that there is a risk that declining fishing activity could reduce the tonnage to below the level required to justify continued dredging, and it is unclear whether offshore wind traffic would be consider a valid replacement.

In terms of working hours, it is reported that the commercial fishing vessels in the harbor currently work on a 24/7 basis with flood lighting at night, which would set a precedent for any additional activity in an OMS base. There is a large residential area near the site, however, and there have been reports of complaints about the level of noise and traffic cause by the existing fishing activity. This may present a challenge for proposals for increasing activity.

Verdict: The commercial/industrial nature of the area means that it should be possible to address the concerns of other port users and local residents but there are likely to be challenges. Early engagement with these stakeholders through public meetings and one-to-one engagement is likely to identify objections and give the opportunity for finding solutions.

Table 9 Summary SWOT analysis of West Ocean City Harbor (Harbor Road) site.

Strengths	Weaknesses
• There is existing, appropriate quayside that has been recently upgraded. • The site is in the West Ocean City area which has a greater focus on commercial and light industrial activities than the town of Ocean City. • There is easy access to the open sea. • An airport is located nearby with options for a heli-base.	• There site is not large enough to accommodate the maximum anticipated size site or allow for expansion without using neighboring sites. • The site is not large enough to accommodate a car park with using neighboring sites. • The harbor is already heavily used by commercial fishermen and leisure craft, including high value recreational fishing.
Opportunities	**Threats**
• The site is currently untenanted with owners that are actively targeting offshore wind activity. • The vacant plot to the south of the site could be used for car parking and the adjacent DNR site could be used for expansion.	• The planning designation of the site may not allow for offshore wind OMS activities so needs to be amended. • The timescales of the Maryland offshore wind programme may mean that the owners of the site opt to lease the site to other users. • The site is located close to a residential area which may result in restrictions on noise and traffic movements. • There is unlikely to be sufficient land or quayside available for a full scale expansion up to 1GW. • The vacant plot to the south of the site could be developed with residential buildings.

Actions for site

- Start early stage dialogue with the owners of the site to understand their plans in more detail, including their anticipated rate of return on their investment to date, their preference for selling or leasing in the short and long term, their capability for investing in infrastructure, the level of interest they have seen to date in the site from parallel sectors and their interest in holding the site for offshore wind.
- Engage with the owners of the adjacent plot of land to the south and the DNR to understand the level of interest in combining their sites with the main site.
- Engage with the relevant departments (including planning and economic development), in Worcester County to understand the barriers to developing the site and their interest in supporting development. This should include dialogue with local politicians to ensure that they are educated about the potential opportunities that will be created by offshore wind.
- Undertake a review of the restrictions of the 'commercial/marine' planning zoning of the site and, if it is likely to exclude offshore OMS activity, undertake a process of revising the zoning to a more suitable type.
- Start discussions with the commercial and recreational fishing communities currently using West Ocean City Harbor to understand their attitude to the proposed use of the site. This process should involve finding out whether this development will restrict the business plans of any fishermen and identifying reasonable mitigation measures that could be taken to avoid any objections. Such an exercise should also highlight the potential benefits that could be generated by the project to the commercial fishing community in the area.
- Undertake an analysis of trends in fishing activity in the port to determine the possibility that traffic levels could fall below those required by the Army Corp of Engineers to continue dredging activity. This activity should also include the preparation of an action plan to address any identified risks.

B. The Cropper Concrete site

Figure 12 The Cropper Concrete site with main site (red), and adjacent site with basin (orange). Image courtesy of Google Maps.

This site is on N 1st Street on the east side of Ocean City town, north of the Harry W. Kelley Memorial Bridge. Also known as the Cropper Concrete site, it was formerly used as a concrete batching facility but this operation was closed and the land was cleared following its acquisition by a land developer for $4.1 million in 2011. The lot is currently vacant except for a temporary car park.

Quayside

The concrete batching plant previously received all materials by road so the main site does not have any marine facilities and the water front is currently rock shielding. The site is directly adjacent to the main channel into the Isle of Wight Bay so there are strong currents and a high number of leisure vessel movements. It is therefore unlikely that a pier could be built out into the water from the site.

Two solutions have been proposed to address this issue:

i. A basin could be dug out of the site to provide a sheltered area for mooring vessels. This may be challenging as the ground conditions of the site are unknown.

ii. The main site could be merged with an adjacent site at its northern end that is currently occupied by a restaurant. This site has an existing basin with a total quayside length of approximately 400ft (120m). This may require the complete or partial closure of the restaurant and the basin will need to be deepened to accept PTVs.

Verdict: The development of a new basin in the main site is likely to be costly but could allow the development of a facility tailored to the developer's requirements. The basin in the adjacent site could offer a cost effective option but would depend on the attitude of the current owner toward the existing activities.

Land area and buildings

The main site is approximately 160,000 sq ft (14,000m^2) and the surface is a mix of rubble, hard packed earth and aggregate on the car parking area. The adjacent site to the north has two buildings on it as well as a car parking area and some landscaping.

Since the closure of the concrete facility, plans for the development of 94 condominiums and townhouses have been submitted and approved. These plans have not been progressed yet but it is likely that the land owner would require an equivalent (or higher) rate of return from an OMS base if it were to abandon this original scheme.

The site does not appear to have an electricity and water supply or internet connection but this is unlikely to be issue because of the local infrastructure.

Verdict: The site is large enough to easily accommodate all of the buildings of an OMS base and associated car parking. The biggest risk of the site is the anticipated high land cost associated with this part of Ocean City and alternative planned use.

Vessel access

The channel next to the site is federally maintained and dredged by the US Army Corp of Engineers to a minimum mandated water depth of 6ft (1.8m). In reality, it is reported that the minimum water depth is in excess of 8ft (2.4m).

The drawbridge on this channel has an air draft of 18ft when closed but it is opened on request during the winter and twice every hour during the summer.

There is a six knot speed limit in the channel but the site is less than one nautical mile from the harbor entrance.

Verdict: Greater certainty about the long term maintained depth of the channel will be required to give confidence to a developer considering locating an OMS base at this site. The drawbridge may present a small restriction on vessel movement but it is unlikely to be a major consideration. Otherwise, the site has easy and quick access to the open sea.

Helicopter base

The site is in close proximity to a residential area so it is considered extremely unlikely that a helicopter base could be established there.

The site is 3.9 miles (6.3km) by good roads from Ocean City Municipal Airport which already has the infrastructure in place to be able to host a helibase.

Verdict: The proximity of the airport to the site is a positive advantage for the site.

Planning

The main site is the only land in Ocean City town that is zoned 'industrial use' which would mean that there would be no restriction on OMS activity.

The site has been cleared of all equipment and buildings but it is reported that the land may be mildly contaminated with vehicle fuel and building materials which may require mitigation measures if disturbed.

A key planning provision of the planned residential scheme on the main site is for the development of a bayside boardwalk along the edge of the site. This is part of the town's wider development plan for the downtown area and a new development that threatened or restricted this long term plan may face political opposition.

Verdict: Subject to a more detailed investigation into the requirements for the bayside boardwalk, planning is unlikely to be a major barrier for this site.

Potential for expansion

The size of the site means that it would easily be able to accommodate the additional land requirements.

The increased demand for quayside would be more challenging to accommodate and would be likely to require the use of both option (i) and (ii), above.

Verdict: Despite the size of the site, unless the new basin is designed with sufficient spare capacity at the start, the availability of quayside could be a significant obstacle to the expansion of this site.

Impact on existing businesses and local residents

Apart from the proposed residential scheme and the restaurant on the adjacent site, there are no businesses that are likely to be impacted by the development of an OMS base on this site. The amount of traffic generated by the site is unlikely to have a major impact on the local road network.

Verdict: The development of this site is unlikely to face challenges from local business or residents.

Table 10 SWOT analysis of the Cropper Concrete site.

Strengths	Weaknesses
• The site is large enough that it could accommodate all activity, including car parking. • The site is currently vacant. • There is easy access to the open sea. • The site is zoned for industrial use so planning is unlikely to be problematic. • An airport is located very nearby with options for a heli-base.	• There is no existing quayside on the site.
Opportunities	**Threats**
• The owner of the main site may feel that an OMS base is an easier means of developing the site than residential buildings.	• The owner of the adjacent site may not be willing to allow PTVs to moor in the existing basin. • Land contaminations may mean that the preparation of a new basin is problematic and expensive. • The owner of the main site may progress with its existing plans for residential buildings. • The developer may not accept the restrictions on the movement of PTVs by the drawbridge. • A lack of suitable quayside may limit the possibility of expanding the OMS base. • The planning requirement for a bayside boardwalk may restrict the development of the OMS base.

Actions for site

- Start early stage dialogue with the owners of the site to understanding their plans for the residential development in more detail, including their anticipated rate of return on their investment to date, their preference for selling or leasing in the short and long term, their capability for investing in infrastructure and their interest in holding the site for offshore wind use. This discussion should consider whether the plans for residential development on the site could simply be reduced to allow the development of the OMS base.
- Start dialogue with the owners of the adjacent site to the north (if different from those of the main site) about the potential to use the basin for the mooring and loading of PTVs and how to provide access to this basin from the main site.
- Engage with the relevant departments, including planning and economic development, in Ocean City to understand the barriers to developing the site and their interest in supporting the development of the site. This should include dialogue with local politicians to ensure that they are educated about the potential opportunities that will be created. In particular, this should include discussion of the proposed bayside boardwalk and the potential impact that this could have on an OMS facility on this site.
- Undertake early stage feasibility studies on the potential to create a new basin in the main site for the mooring and loading of PTVs. This should take account of the anticipated contamination of the land and provide an indicative cost for providing enough quayside for the baseline wind farm and a 1GW expansion.

C. Ocean City Municipal Airport

Figure 13 Ocean City Municipal Airport site with inlet (red) and sites indicated as available for development by airport management (orange). Image courtesy of Google Maps.

This site is the Ocean City Municipal Airport which is located south of West Ocean City. The airport is owned and operated by the town of Ocean City and mainly used by light leisure aircraft and tour operators.

Quayside

There is no existing quayside at the site but there is a small inlet next to the car park on the eastern side of the main complex. This inlet was originally dredged in the 1960's for leisure activities but has not been in use for a long time. No maintenance has been carried out on the channel so the depth is unknown but the airport management confirms that it does not dry out.

At the head of the small inlet is a wider pool with some old wooden structures that could potentially be replaced with berthing pontoons for PTVs with provision for load bearing areas for loading vessels.

Verdict: The lack of information about the current state of the inlet means it is not possible in this report to gauge the technical difficulties of establishing appropriate infrastructure. Such a development would, however, give a developer freedom to set out a bespoke layout that was set apart from other marine traffic in the area.

Land area and buildings

The airport has a total footprint of approximately 25 million sq ft (2.3 million m^2) with two runways, taxiing areas, a terminal building and a number of hangers.

The airport has a long term business plan to develop new buildings to the north west of the existing hangers as well as ground preparation work in the triangle between the two runways. It is currently undertaking environmental impact assessments for two sites to the north of the complex but the management says it is also flexible to consider other developments elsewhere on the site.

The identified sites do not have electricity and water supply or broadband internet connection but this is unlikely to be an issue because of the local infrastructure.

Verdict: The site has a number of locations that would be large enough to easily accommodate all of the buildings of an OMS base and associated car parking.

Vessel access

Neither the inlet nor the channel to the harbor mouth is federally maintained so any dredging activity would need to be done privately. Beyond the small inlet, the channel to open sea is reported to be between 7ft and 11ft but is also used for a lot of leisure activities including fishing and jet skiing.

Verdict: As with 'Quayside', the lack of information about the current state of the inlet means it is not possible in this report to gauge the technical difficulties of dredging. It is noted, however, that the cost of this activity (and the disposal of spoil) is likely to be high.

Helicopter base

The airport already has the infrastructure in place to be able to host a helibase and there is the potential for dedicated facilitates to be developed if required.

Verdict: The establishment of a helibase at the airport would be relatively simple and inexpensive.

Planning

The land in the airport is zoned for industrial use and is far away from most residential areas so would not pose any planning challenges. Helicopters would need to operate within set times but this is already standard practice in the industry.

The inlet is surrounded by marsh land and is located within an area zoned as "extremely environmentally sensitive". As such, obtaining planning consent to dredge or install any infrastructure is expected to be extremely difficult.

Verdict: While the land-side elements of the OMS base would not face any planning difficulties, the waterside elements are likely to be problematic. Such a development is likely to require a long and costly planning application, and risk opposition from the environmental lobby.

Potential for expansion

The size of the site means that the expansion of the landside facilities would not be difficult.

For the waterside facilities, the increased demand would require additional capacity to be added to the pontoons that had been installed. The precedent of existing infrastructure might make planning approval either easier (through better knowledge of the terrain and wildlife, and a track record of sustainable delivery) or more challenging (due to cumulative impacts).

Verdict: Despite the size of the site, unless the waterside infrastructure is designed with sufficient spare capacity at the start, the availability of quayside could be a significant obstacle to the expansion of this site.

Impact on existing businesses and local residents

There are no businesses or residential areas that are likely to be impacted by the development of an OMS base on this site. The amount of traffic generated by the site is unlikely to have a major impact on the local road network.

Verdict: The development of this site is unlikely to face challenges from local business or residents.

Table 11 SWOT analysis of Ocean City Municipal Airport site.

Strengths	Weaknesses
• The site has a number of areas that are large enough to accommodate all activity, including car parking. • These sites are currently vacant. • The site is zoned for industrial use so planning is unlikely to be problematic. • The site is remote from all residential areas so any developments would have very little impact on the local population.	• There is no existing quayside on the site. • The inlet is zoned as “extremely environmentally sensitive” so obtaining planning permission could be difficult. • The inlet is currently too shallow so would require dredging.
Opportunities	**Threats**
• The port activities could be co-located with the heli-base so all buildings could be consolidated on one site.	• The channel is not federally maintained so siltation could occur that would need to be dredged privately by the offshore wind owner (or other responsible party).

Actions for site

- Undertake investigations into the current state of the inlet and outer channel to determine the potential for it to be dredged and for suitable pontoons or quayside infrastructure to be installed. This should include a consideration of the capital cost of such activity and the likely long term cost of maintaining the channel.
- Engage with Worcester County planning department to consider how an acceptable planning application could be developed.

D. Site combination

Figure 14 Road links between identified sites. Image courtesy of Google Maps.

Overall, the three sites that have been identified in the Ocean City area all have strong potential to be used as the OMS base port for offshore wind farms located off the coast of Maryland.

The risks in terms of land available on the West Ocean City Harbor site, land costs on the Cropper Concrete site and quayside infrastructure at the Ocean City Municipal Airport may be obstacles to their development.

One solution to this problem would be to adopt a split-site approach in which the main offices and warehouses were set up at a different location from a smaller 'technician terminal' port facility.

The most likely option for such a split-site approach would involve locating the office buildings and warehouses on the Ocean City Municipal Airport site. This is because this site has significantly more land immediately available than the other sites, lower land cost, no anticipated planning restrictions and the benefit of co-locating these buildings with the helicopter base.

The port facility could be located at either the West Ocean City Harbor site or the Cropper Concrete site in Ocean City town. It is assumed that the lower capital investment required for the West Ocean City Harbor site means that this option would be preferred.

As the two sites are less than three miles from each other, it would be possible for the responsible party to easily transport spare parts and consumables from the warehouses at the airport, to be ready at the port facility at short notice.

Table 12 SWOT analysis of a combination site option.

Strengths	Weaknesses
• There would be no restrictions in space on the landside infrastructure at the airport and a reduced level of constraint at West Ocean City Harbor site.	• A split site strategy may not be attractive to a developer that is focused on a single site approach
Opportunities	**Threats**
• Improved opportunity for expansion compared with all other sites.	• West Ocean City Harbor site may be taken by other traffic. • The amount of capacity available at West Ocean City Harbor may still be a constraint on capacity.

Actions for site

- Undertake a transport analysis to confirm the likely levels of traffic along the route between the two sites at different times of the day to identify any potential challenges that could cause delays or logistical complications.

9.2. Ocean City site summary

This analysis of sites in the Ocean City area demonstrates that there are strong candidates to be selected as the OMS base for offshore wind farms in the Mid-Atlantic region although a proactive approach is required by site owners and public enabling bodies in the region.

Key strengths for the region that should be considered in future engagement with developers of offshore wind projects include:

- Ocean City (and the surround region) is the closest port site to the Maryland WEA and is well positioned to serve projects in the proposed Delaware WEA.
- All identified port sites in Ocean City are located in close proximity to Ocean City Municipal Airport which has the capacity to act a helibase for OMS activities.
- Ocean City, and neighboring areas including Salisbury, will be able to train and support the work force that will be required by offshore wind OMS.
- The business community in Ocean City has already shown itself to be interested in supporting offshore wind developments and is proactively engaging with efforts to attract activity.
- All identified sites have access to a good road network.

10. Blueprint for developing a Maryland OMS base

The completion of the first Maryland offshore wind farm may still be some years away but there are many actions that stakeholders and the business community in Ocean City and Worcester County need to be taking to proactively secure their region as the location of the OMS base and to maximize the economic impact.

The following recommendations are based on discussions with developers and public enabling bodies in the UK and the rest of Europe about their experiences of setting up OMS bases.

10.1. A regional OMS delivery group

A consistent theme of industry feedback is the benefit of establishing a single, collaborative 'delivery group' that can coordinate the actions and decision making of local public authorities and other stakeholders involved in the offshore wind project.

Ideally, this working delivery group should include state, regional and local authorities, public enabling bodies (such as the Chamber of Commerce) and the developer. In particular, it should include representation from both Ocean City and Worcester County, regardless of which site is progressed.

The creation of such a group has a number of advantages:

- It allows any funding to be pooled and ensures that enabling actions are coordinated and not duplicated.
- It facilitates communication between the developer and all stakeholders. The developer can highlight barriers it is facing and stakeholders can voice concerns and suggestions, facilitating a collaborative environment.
- It acts as a focus for public interest in the project and helps ensure that the local community is educated about the potential benefits and opportunities associated with the project, and give them a means of expressing their concerns.
- It brings a focus for the local supply chain and ensures that processes are put in place to educate companies in the area about the opportunities, and helps them engage with the developer (and its Tier 1 suppliers).

10.2. A year-by-year action plan

This section sets out a high level, year-by-year schedule of the activities that the developer of the Maryland project is likely to be taking, with a particular focus on the development of the OMS base. It then sets out recommendations on the actions that can be taken each year by a coordinated regional OMS delivery group, or individually by stakeholders if no such group is established.

For the purposes of this report, there is a countdown to 'Year 0' which is assumed to start once the final turbine has been commissioned and control of the wind farm has fully passed to the operational manager.

Year -5

Developer actions

- Undertake concept engineering studies for the wind farm (in partnership with shortlisted turbine and balance of plant suppliers). This includes consideration of a preferred OMS strategy (port-based or offshore-based) based on anticipated technology choices, project location and size.
- Start early engagement with ports and local authorities to identify infrastructure that could support OMS activities and identify any major barriers to development. This process also ensures that port owners are aware of the potential opportunity so that they can start to prepare development plans.
- Undertake a high level review of regional resources around potential OMS sites, including the availability of relevant skills in the local labor force, transport links to potential port sites and the presence of an existing supply chain for key components.

Potential actions by the OMS delivery group

- Undertake a review of the specific skills that will be required by the companies involved in the OMS operation and assess the current capacity of the region to provide a suitable work force in the timescales of the project. This process should also include the preparation of an action plan to address potential bottlenecks through local colleges or other training providers.
- Collaborate with local planning offices to prepare outline 'route maps' to show the developer and turbine supplier the timescales for obtaining all relevant planning permissions for each site.
- Support early engagement between the developer and local stakeholders, in particular the commercial and recreational fishing fleets. This should involve discussions about the potential impact of the project on the area as well as early education of the fishing community about the commercial opportunities that will be generated locally.
- Engage with landowners of prospective sites to support the preparation of development plans and identify barriers to progress.
- Build on existing industry analysis about the likely impact of the project on recreational fishing activity, particularly marlin fishing. This should be used to prepare a concise and easily accessible document that can be shared with relevant stakeholders to reduce

concerns about the impact of the wind farm and raise awareness of any potential benefits.

- Start a newsletter for the regional business community to ensure that they are aware of the plans being proposed, the progress that has been made to date and the potential supply opportunities for local companies.
- Investigate how to raise awareness (at a state and national level) about the region's role in the project and consider how to use this to increase tourist interest. This could involve a review of successful initiatives undertaken at other onshore and offshore wind farms.

Year -4

Developer actions

- Enter detailed negotiations with shortlisted Tier 1 suppliers for each of the main work packages for the wind farm itself. This includes discussion on the length of the warranty period provided by the turbine supplier.
- Engage in detail with a short-list of preferred OMS port locations to confirm options for port layout and commercial terms.
- Upon completion of this process, agree heads of terms with the owner of the preferred location setting out the planned land area and the long term costs covering rent and other charges.

Potential actions by the OMS delivery group

- Support detailed engagement between the developer and the local planning office to identify potential concerns with planning applications at an early stage. This may include the impact of construction noise or the level of traffic that would be generated. This process will allow these concerns to be addressed and ensure a smoother approval process.
- Maintain ongoing engagement with commercial fishing fleets and local interest groups to ensure that new issues are identified and addressed.
- Start early engagement with local colleges and training providers to identify the potential for developing new training courses to meet future demand for skills in Maryland and along the east coast. This should consider the specific infrastructure that might be required (such as climbing rigs or simulators), the cost of implementing such measures and the likely level of demand required to justify investment.
- Facilitate introductions between local colleges and experienced training providers in Europe. This activity should include consideration of possible joint ventures.

Year -3

Developer actions

- Complete the final investment decision (FID) for the project and confirm orders with suppliers of turbines and balance of plant items.
- Start work on the onshore substation, including site preparation and onshore cable installation.
- Obtain planning approvals for port and landside infrastructure at the selected OMS port. If the OMS port is also going to be used for construction support, then the developer will also start making investment in offices, warehouses and port infrastructure to be ready for the start of offshore installation activity in the following year.
- Set up a local office to lead engagement work with the local population and support survey activity.

Potential actions by the OMS delivery group

- Collaborate with the developer to open a public drop-in center (potentially linked with its local office) with staff available to answer questions about the project and interactive activities for children to stimulate enthusiasm.
- Support the establishment of a supply chain website that acts as a focus for local supply chain development. This can include updates on the project's progress, timescales for future tenders and a registration portal for local companies to explain their capabilities. This website should be regularly updated with news and information.
- Undertake a supply chain assessment of local capacity and, in collaboration with the procurement team of the developer, identify bottlenecks or gaps relating to OMS. This should led to the development of an action plan for addressing these issues and involve investment by local companies, joint ventures or inward investment.

Year -2

Developer actions

- Start offshore installation works for balance of plant items including foundations, cables and offshore substation.
- If the OMS base is being used for construction support, then personnel and equipment will be transferred to the offshore site from the port and the start of recruitment and training of onshore and offshore staff.

Potential actions by the OMS delivery group

- Set up monitoring processes, in partnership with the developer, to record orders placed with local and regional businesses (either by the developer or its suppliers).

- Maintain regular dialogue with the developer to identify new supply chain bottlenecks and proactively identify local or regional suppliers that can help.

Year -1

Developer actions

- Undertake offshore installation works for turbines followed by the final commissioning of the project.
- If the OMS port is only going to be used for service and maintenance activities, then the developer will start making investment in offices, warehouses and port infrastructure.
- As turbines are installed and commissioned, control of the site is gradually passed to the operational manager.

Potential actions by the OMS delivery group

- Follow up with the local companies that are winning work to understand whether the new activity is generating new jobs. Use this (and other evidence) to produce reports on the indirect impact of the project on the local and regional economy.

Year 0 and beyond

Developer actions

- Start full scale OMS activities with planned maintenance and unplanned service campaigns.

Potential actions by the OMS delivery group

- Monitor levels of activity, both in the port and the local road network, against forecasts. This information should then be used to review expansions plans to ensure they are still sustainable and effective.
- Continue to engage with the developer and local supply chain to identify new opportunities for local supply and skills development.

Case study #5: A regional delivery group

Feedback from offshore wind developers is that a successfully implemented regional delivery group can have a positive impact on local supply chain growth and project implementation.

The 700MW Rampion project is located in the English Channel on the south coast of England and the developer, E.ON, has highlighted the achievements of its local delivery group, Sussex Wind Energy.

This group is composed of E.ON, the local and regional public authorities for the coastal region and two economic enabling bodies for the county.

E.ON report that the group has played an important role in funding supply chain events, setting up a website that has focused interest from local companies and ensure that local initiatives are joined up. As a result, it believes that local stakeholders feel more engaged and that this helped in its successful planning application.

To see its website, go to www.sussexwindenergy.org.uk.

Appendix 1: Consultees

The following contacts and organizations were engaged with during the course of this project.

Contact	Organization
Bill Badger	Worcester County Economic Development
Dane Bauer	Diversified Building Solutions
Lee Beauchamp	Wicomico County Public Works
Bill Bradshaw	Worcester County (Engineer)
Ernie Colburn	Salisbury Area Chamber of Commerce
Jaime Giandomenico	Ocean City Municipal Airport
Susan Jones	Ocean City Hotel Motel Restaurant Association
Meredith Mears	Worcester County Economic Development
Terry McGean	City Engineer for Town of Ocean City
Matt Odachowski	Royal Plus
Jake Robinson	Seaboard
Melissa Schmid	Diversified Building Solutions
Ed Tudor	Worcester County (Development)
John Tustin	Worcester County (Public Works)
Ruth Waters	Harrison Group
William “Bo” Weaver	Watershed Marine