Building Information Modelling for offshore wind projects: improving working methods and reducing costs

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Summary of findings

• In the UK, the adoption of BIM has increased significantly over the last five years. In a recent survey 48% of design and construction professionals said they are already using BIM, with 83% planning to use BIM within the next year (1).

• The UK Government Construction Strategy 2011 cites a 15-20% cost reduction target, with BIM as a key facilitator (2). BIM is now mandatory for all centrally-procured public projects.

• A key objective for offshore wind is to reduce costs. Where BIM has been deployed in other sectors it has not only demonstrated the potential to reduce costs for offshore wind, but also to impact on overall project budget, number of contracts, interfaces between contributors, level of design complexity and project duration.

• The offshore wind industry has not yet adopted BIM. The complexity and duration of a typical project are perceived as potential barriers, but there are proven examples across other similar sectors that demonstrate these can be overcome.

Recommendations

• An appropriate industry body should quantify the potential benefit of BIM to offshore wind by reviewing the efficiencies and cost reductions achieved across sectors that have adopted BIM.

• An appropriate industry body should analyse how the regulatory environment for offshore wind may impact BIM adoption.

• Appoint a champion (the Offshore Wind Programme Board (OWPB) is ideally placed) empowered to progress the application of BIM across the sector. Candidate tasks should include exploring potential benefits, explaining the implications of BIM and setting up ‘live’ project demonstrations.

• Developers should engage and be encouraged to familiarise themselves with BIM; understand the benefits, existing users’ experiences and how this aligns with government strategy.

• Develop a demonstration project, supported by an appropriate champion to increase understanding and awareness of BIM. Small-scale projects would be most appropriate, such as an offshore wind demonstrator, tidal energy or onshore wind project.
Introduction

The UK Government has made it clear that the offshore wind industry will only continue to attract support if it reduces costs.

The Cost Reduction Monitoring Framework (CRMF) (3) records how costs have been reduced within specific developments. The CRMF has shown that the greatest reductions have been realised in turbine technology and scale, market competition and cost of equity.

These high level findings suggest the industry is on track to deliver a levelised cost of energy (LCoE) of £100/MWh by 2020.

Further reductions need to be realised in areas such as balance of plant, transmission and installation. Strategies also need to be developed to further reduce LCoE, post 2020.

BIM offers potential to improve the outcomes and contribute to cost reduction through the benefits of improved supply chain involvement and knowledge sharing (4) – both of which were identified as offering potential for future cost savings.

In this paper we describe how new collaborative systems of working in similar industries deliver savings in both capital expenditure (Capex) and operational expenditure (Opex) project phases. We explore what potential these have to drive down costs in the offshore wind sector.

What is BIM?

Building Information Modelling (BIM) has driven a revolution in project planning and execution for infrastructure and built environment projects.

BIM is a digitally-enabled design and information management process which combines technology, people and processes. An important component of BIM is the use of comprehensive 3D computer-aided design (CAD) models. The process also supports structured collaborative working, where all parties communicate and share information in a planned and standardised way.

To truly leverage benefit from BIM, organisations must be willing to embrace fundamental change in the way they exchange information. The roles and responsibilities that people take and the agreed protocols which define how information is shared with other contributors will all be required to change. The ethos of working from a common, aligned platform is at least as important as the technology enabling collaborative working.

As it matures and is becoming more widely adopted, BIM is playing a significant role in delivering efficiencies and cost savings across the the architecture, engineering and construction industry.
BIM characteristics

BIM offers a defined structure and framework (see Figure 1). Standards and Publicly Available Specifications (PAS) define project roles and standard processes. Employer’s Information Requirements (EIR) are drawn up at the beginning of a project and comprise:

• An information management strategy which defines the standards for document delivery and any input data required by the team to formulate a plan which satisfies the project requirements.
• Commercial documents which include data sharing agreements, software requirements, definition of responsibilities which set the standards for information management.
• Competence assessments which are used to rate the capabilities of both the personnel and IT systems of potential project partners.

The supply chain responds to EIR with a BIM Execution Plan (BEP) allowing both the employer and the supply chain to understand the proposed information requirements before a project begins.

Once contracts are awarded, a Master Information Delivery Plan (MIDP) detailing milestones and responsibilities specific to the project is created. This plan also defines project specific details such as data formats, numbering and naming conventions before any work takes place.

A Common Data Environment (CDE) allows individuals or sub teams to work seamlessly in a shared digital environment and enables everyone access to information at an early stage. Working in a CDE allows:

• Private work in progress area for each party.
• Information sharing in draft or ‘for collaboration’ state with all parties.
• Information sharing in final or ‘for construction’ state with all parties.

The ability to share information through a structured CDE allows everyone, particularly contractors and/or the supply chain to have access to project information at an early stage. This avoids confusion and duplication, as well as facilitating communication based on current, up-to-date information.
The case for BIM

From April 2016 the use of BIM will be compulsory on Government construction projects. Recently the National Building Specification (NBS), part of the Royal Institute of British Architects (RIBA), surveyed professionals from across architecture, engineering and construction. The survey found that 48% said they are already using BIM, with 83% stating that they plan to use BIM within the next year (1). The primary motivation for the Government mandate is to increase efficiencies and reduce costs. The objective is to achieve target savings of 15-20% on construction and lifecycle costs by using BIM to integrate project teams, share information, support appropriate contractor engagement and facilitate collaboration (2).

BIM not only enjoys Government support, but also an increasing enthusiasm from industry professionals as it becomes more widely used across architecture, engineering and construction projects. BIM has been key in the successful delivery of CrossRail (5) for instance. The number of projects which have benefitted from the adoption of BIM is expanding. Equally, the level of experience amongst customers and the supply chain continues to grow.

There is a common imperative shared by centrally-procured infrastructure projects and the offshore wind industry. The UK Government has made it clear that both sectors will only continue to attract support if they reduce costs. However, unlike the construction sector, it is not mandatory for the offshore wind industry to adopt BIM, yet key characteristics, such as the practice of sharing information through an online CDE will be familiar to offshore renewable energy professionals.
Barriers to the adoption of BIM in offshore wind projects

There are a number of potential barriers which could hinder universal adoption of BIM in offshore wind projects.

1. The timeline required to develop and execute an offshore wind project.
   An offshore wind project can take over ten years to move from site selection, through feasibility, consent, support contract auction, development, and then into construction and operation. Working with these timeframes, a developer is unlikely, or may be unable, to select suppliers at the start of the project. This diminishes the opportunity for essential EIR dialogue. Additionally, it may not be feasible to set up and maintain a CDE from project inception, considering the length of the journey, number of participants, the way these participants will enter and leave and the various phases of a typical offshore wind project.

2. Reluctance to share information.
   The supply chain operates in a competitive environment and there is generally a reluctance to share information unless absolutely necessary. This is particularly the case where suppliers consider information sharing may either erode their competitive advantage or be available, even indirectly, to their competitors. They are also wary about sharing information on the basis that it could be used to influence contract negotiation or pricing of subsequent projects. This state of affairs can be exacerbated by the complex consortia structure usually required to deliver projects on the scale of an offshore wind farm.

   There is evidence that significant shifts in mindset have facilitated the adoption of BIM across other sectors and there is no reason to believe that similar movement will not be possible within the offshore wind industry.

3. Contractual and legal constraints.
   In many of the phases of an offshore wind project there are contractual and legal requirements that make information sharing challenging. For example, when procuring a transmission asset, developers are focussed on the potential scrutiny the asset will be subjected to as part of the OFTO transaction. Developers are not incentivised to share information about an OFTO asset and they may be constrained by law and regulation of procurement practices.

   Regulatory requirements need to be reviewed and amended to enable optimum adoption of BIM in offshore wind.
4. **Spend profile.**
   
   Figure 2 demonstrates how BIM reduces spend by enabling a shift in effort to earlier stages of the project. Work at preliminary and detailed design phases offers better value than amendments during final design and construction. The earlier the change is made, the lower the cost, and the greater the potential opportunity to reduce the overall spend. In a typical offshore wind project, the reverse of the BIM strategy applies. This is because there is a reluctance from developers to optimise a project (and incur expense) while still awaiting results of a Contract for Difference (CfD) auction and decisions on planning consents. Developers seek to balance the capital at risk with the likelihood of project success and the result is that projects tend to be biased towards a model of increasing spend later in the detailed design phase.

![Figure 2: Macleamy Curve on the BIM Process, Patrick Macleamy](image)

5. **Relationships between design, construction and operations.**
   
   There are considerable benefits in including O&M as part of the up-front spend and in collaborating and sharing information in a CDE. Offshore wind already has commercial and regulatory imperatives to consider O&M during the design phase. However, offshore wind projects rarely appoint an O&M contractor sufficiently early in the process to realise all the potential benefits of early engagement. Original Equipment Manufacturers (OEMs) commonly provide at least an initial period of O&M service for a wind farm prior to an independent O&M contractor being appointed.

   Deploying BIM methodology to enable full collaboration between owner, designer, OEM and subsequent O&M contractor may be challenging because of the differing motivations of these parties.

   The optimisation of through-life cost (versus capital expenditure) should logically be a primary objective. However the structure and delivery of offshore wind projects tends to drive lenders and investors to focus on achieving income and profit as early as possible at the expense of optimised Opex spend.
6. **Transactions.**

Offshore wind projects are frequently subject to transfer or transactions. For example, a developer may commonly aim to divest a percentage stake at a certain stage. BIM ethos is focused on transparency and information sharing, but this characteristic is not always likely to be compatible with the way projects are financed.

How project financing impacts on the adoption of BIM will be a key influence. At present, information sharing may be hindered by actual or perceived risks related to financing. To align with BIM, a step change in the way transactional negotiations are conducted is required.

7. **Investing in new systems.**

A project developer is already likely to have invested time and effort in setting up systems and process, including online or CDE-type data sharing systems. The existence of some of these systems may hinder full adoption. BIM uses an holistic approach rather than implementation-focused systems and the requirement to revisit and possibly replace existing systems and technology could present a challenge if the driving need or motivation behind the change is not understood and embraced.

8. **Additional effort.**

The additional work required to define EIR at project inception may be perceived as a barrier by a developer or a third party such as the consenting authority, or both.

In light of these potential barriers and without a clear mandate or requirement to change, it is unlikely that a BIM approach will be adopted in offshore wind in the near future. Although there is a clear desire for cost reduction, there has not been a universal need described by potential end users for BIM type systems, and the true potential savings are both unknown and difficult to assess. If these barriers could be overcome, projects may benefit from improving the opportunity for CfD auction success, reduced LCoE and financing costs.

**How can these barriers be overcome?**

There are powerful examples of projects with similar challenges that have successfully adopted BIM. Two are described below:

1. The Crossrail project is successfully demonstrating that a highly complex contracting structure and long running project can both implement and benefit from BIM (5). The project is using a single linked system of BIM databases across 25 design contracts, 30 main works contracts and 60 main logistics contracts. Ensuring that work has been carried out in a collaborative 3D environment was defined as a core contractual requirement from the outset.

2. The integration of BIM is crucial to the delivery of the new Hinkley nuclear plant, a project with security requirements of national importance. The British Standards Institution Publicly Available Specification BSI PAS 1192-5:2015 provides guidance on security and information security for collaborative BIM and this project demonstrates that high levels of information security does not preclude the use of BIM.
The primary mechanisms for managing the security of exchange of information in BIM are either to rely on contracts to prevent information being used outside a specific project, or in the instance of more sensitive information, excluding it from a CDE. When information is excluded from a CDE much of the advantage of collaborative BIM is lost. The hesitance to share is as much a barrier imposed by mindset as it is by project requirements but has been overcome elsewhere.

**Regulation**

In order for BIM to be widely adopted, and hence deliver maximum positive impact there are areas of regulation where change may be required. For example, the existence of regulations around OFTO transactions or competition and procurement need not prevent the roll-out of BIM. However, a change in regulations may enable a more rounded adoption. Detailed industry consultation is required to understand which existing and future regulatory requirements for offshore wind projects may be influenced by BIM.

**Spending ahead of CfD award**

The benefits of spending more on feasibility and initial design are understood by the offshore wind industry, but developers are discouraged from putting additional capital at risk both by a lack of long term visibility, and the risk associated with the support auction and consents processes. Whilst recent announcements have confirmed the number of auction rounds and a budget of £730m to 2026 there is no reliable understanding of what Government support may be available. This applies to projects which do not win CfD in the next three rounds and those that may need to take final investment decisions further into the future. Developers see spending ahead of CfD award as ‘at risk’. Greater clarity from government would be required on the long term trajectory of offshore wind to help support earlier investment decisions and allow the industry to move towards an ideal BIM project spend profile.

**O&M engagement**

It is also already recognised that engaging early with O&M contractors leads to cost savings and greater efficiency throughout the whole life of the asset – from concept design to decommissioning. This is not an attribute unique to BIM or to the offshore wind sector. Industries such as combined cycle gas turbines (CCGT) also strive to achieve the most cost effective balance of OEM support, cost of risk and O&M costs.

It is worth comparing a BIM enabled approach with two typical approaches, both of which represent standard strategies. Consider a less collaborative approach where an OEM is engaged for a long initial service contract. This results in lower financing costs, but stifles collaboration. It may also restrict some opportunities to optimise for Opex once a project is in a mature operating phase. In contrast, an alternative could be to work collaboratively and engage an O&M provider early. This may increase other costs and/or push spend earlier in a project, but may reduce overall lifetime costs. There is clearly a variety of approaches to consider when balancing the benefits of BIM in offshore wind.

**Managing change**

Achieving greater appreciation of how a project can benefit from BIM is primarily an issue of education and managing a change in approach and ethos. To achieve successful adoption of BIM in any organisation, there is a requirement for ownership and encouragement, as well as willingness to migrate to new technology.
Encouraging users who may already have some level of investment in common data environments to go further and use them in a more collaborative way may require support from a BIM champion. The role of a champion is to help overcome any reluctance to invest and educate people about the benefits and advantages of collaboration, within the context of their own projects or areas of expertise. For instance, BIM would offer distinct advantages by enabling both lower cost and lower risk transactions for projects which are the subject of transaction(s) or transfer.

Lessons learned from the offshore wind industry
As a relatively mature industry, offshore wind has amassed a large body of knowledge and experience. Tapping into existing lessons learned is an ideal way to draft effective EIR based on past experience. While there is still the requirement to draft content, much of the information may already exist and could be repurposed.

Where would BIM offer an advantage?
The adoption of BIM has been influenced by the Government’s drive to reduce costs. While not centrally procured, offshore wind requires continued Government support while it continues on the journey of LCoE reduction, at least in the medium term.

Recent Government signals suggest that additional qualifying criteria, such as local content, will play a more active role in the assessment of CfD bids in future rounds. It is plausible that further scrutiny and requirements will be imposed on future CfD awards. Seen in this context, a project using BIM would at least be seen in a positive light. If included in a supply chain plan for example, it would be perceived as encouraging both cost reduction, innovation and supporting a methodology already championed by Government.

Adoption of BIM in offshore wind could be driven either by:

- Proactive developers including BIM in their bids to a support auction.
- A more explicit requirement to include BIM as a condition of CfD award.

Areas where offshore wind projects would expect to leverage an advantage by adopting a BIM approach and deliver savings include:

- **Condition-based maintenance.**
  BIM offers the opportunity for design and O&M project phases to align without alienating construction and commissioning, and an earlier and more bilateral dialogue between O&M and the design team. A typical beneficial outcome would be linking monitoring system data with asset management data to deliver proactive and more cost-efficient maintenance regimes based on prognostics.

- **Structural health monitoring.**
  A project which continues to communicate at all stages has advantages. For example, inclusion of structural health monitoring at the design phase means that information on the monitoring system is available in the O&M phase and data continues to be available to the employer. The designer would be able to integrate this feature to support life extension. Analysis of design life data may unlock additional revenue and lower the through-life cost of energy. Monitoring approaches such as these
are aligned with BIM in that they share information and are taken into consideration from initial
design through to end-of-life to offer maximum value.

- **Transactions.**
  Collating shared project data in alignment with BS1192 will streamline and improve projects
  through standardising the due diligence process. This will both reduce the cost of a transaction, the
  associated risk and may lead to a higher value asset for the employer.

- **Data management and sharing.**
  By creating a platform to share all data between everyone, a full and common reference source
  emerges. This results in a less segmented approach to survey, environmental, feasibility and
  concept design data collection and management and enables more accurate designs to be drawn
  up earlier in a project.

Supply chain innovation is encouraged by being prescriptive only about the data requirements in the
procurement process, not the method of collection (for example from survey) or delivery. Greater
transparency and combination of datasets may also offer unforeseen insights through emerging
techniques such as big data analytics. This is likely to be particularly powerful when a developer or
contractor has a portfolio of projects on which they can perform analyses.

**Conclusions**

Although there is a clear desire for reducing cost, there has not been a sector-wide drive to adopt BIM
type systems in offshore renewable energy. A more collaborative approach such as BIM, demonstrates
the potential for savings across offshore wind projects. But the true potential savings are unknown and
difficult to assess.

If barriers could be overcome, projects may benefit from improving the opportunity for CfD auction
success, reducing financing costs and LCoE and increasing the attractiveness of projects and the
industry in general to Government.

The CRMF (3) can be used to lend industry context to these findings. While the framework does not
specifically track the integration of BIM in offshore wind, both supply chain involvement and knowledge
sharing are components of BIM and were identified as offering potential for future cost savings.

The competitive auction process discourages intercompany knowledge sharing. Having a structure
aligned to an applicable standard (5) (6) for BIM will provide a management system for the exchange
of information and give participants confidence that a balance can be struck between collaboration and
confidentiality.

The construction sector has demonstrated that by adopting BIM, revolutionary change is achievable.
Similar efficiencies and savings are possible in the offshore wind industry.
References

4. **Cost Reduction Monitoring Framework Evidence log 2015.**
5. http://www.crossrail.co.uk/construction/building-information-modelling/#
8. **ARUP. BIM in Offshore Renewables** *A Review of BIM for Offshore Renewables 2016.*

* Figure 1: Permission to reproduce extracts from British Standards is granted by BSI. British Standards can be obtained in PDF or hard copy formats from the BSI online shop: www.bsigroup.com/Shop or by contacting BSI Customer Services for hardcopies only:
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Recent project highlights include delivery of a performance assessment campaign to quantify the real-world cost of energy impact of turbine blade damage, and the role of engineering lead on the Cost Reduction Monitoring Framework (CRMF) for 2015.

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