OPIN value chain analysis

A presentation for the OPIN workshop: Energy Policy and Offshore Renewables State of the Nation

BVGassociates

Agenda

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Selected clients

BVG Associates (BVGA)

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- Policy
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Technology

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- Engineering services
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- Due diligence
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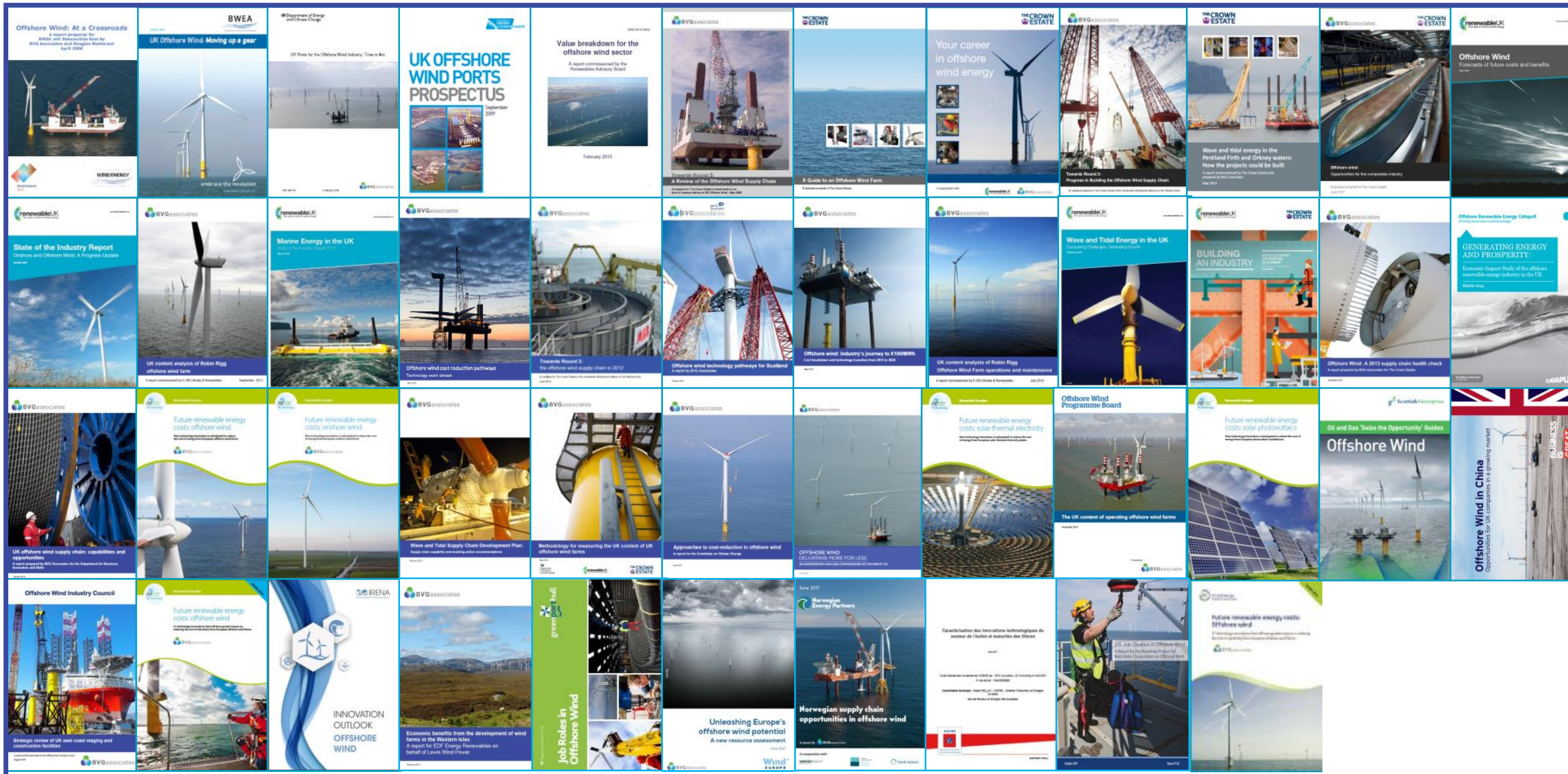
- Technical review

Public reports



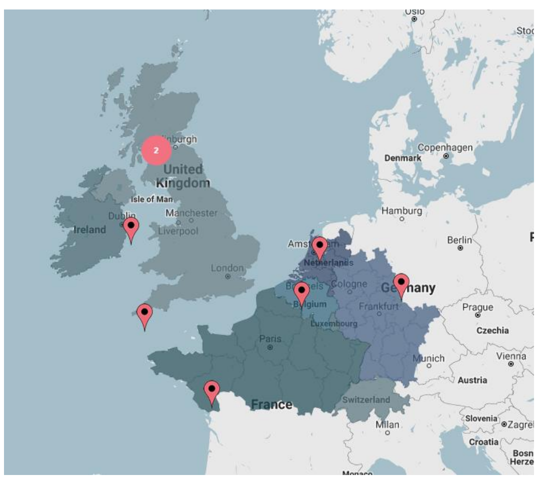
1. Introduction

OPIN

The OPIN network

- Ocean Power Innovation Network (OPIN)
- 3 year project, €2.6m budget
- Led by Sustainable Energy Authority of Ireland (SEIA)
- Eight project partners from six North European countries

"The basic premise of OPIN is to encourage both **cross-sectoral** and **cross-regional** **collaboration** for Offshore Renewable Energy SMEs. Cross-sectoral collaboration will bring already proven expertise, capabilities and products from other sectors into the ocean energy sector. This will help to reduce costs and accelerate technology development."



Purpose of the study

- Analysis of the current value chain for three renewable energy technologies:
  1. Tidal stream
  2. Wave
  3. Floating wind
- To give OPIN partners a picture of the current size and composition of the value chain, covering the full project lifecycle:
  1. Development and project management
  2. Device supply
  3. Balance of plant (inc. transmission)
  4. Installation and commissioning
  5. Operations, maintenance and service (OMS)
  6. Decommissioning
- To point out gaps and opportunities in the current value chain, within the OPIN regions
- Identify the key sectors for the OPIN network to engage with.
- Provide general information and contact details for the different clusters and organisations that OPIN could engage with.

2. Methodology

What we did

- Desk based research
- For the three technologies and the six areas of the value chain, we examined:
    - What are representative costs for an early stage commercial system?
    - Who are the key companies and organisations involved?
    - What is the maturity of the technology and supply chain?
    - What is the capability in each OPIN partner country?
- Based on the above, we formulated some conclusions and recommendations for OPIN:
    - High level recommendations based on renewable technology and partner country.
    - Technology recommendations, giving our opinion on where OPIN could best create value in the value chain.

The report

- Prepared by BVGA, with input from OPIN partners
- About 150 pages (excluding appendices)
- Main content: tables of the companies in each member country who have expertise in the value chain elements
- Appendices include contact details of companies and organisations for engagement

This presentation: focussed on parts of value chain where cross-collaboration would be beneficial

3. Representative costs

Purpose: to give an indication of most significant aspects of value chain

Technology	Device type	Device rating (MW)	Farm size (MW)	Year of FID	Data sources
Tidal	Bottom-fixed horizontal axis turbine	2MW	<10	2020	Derived from confidential data source
Wave	Bottom-fixed point absorber	1MW	<5	2020	Derived from academic literature
Floating	Semi-sub floating platform	8MW	<40	2020	BVGA cost models

Element	Unit	Tidal	Wave	Floating
Development and project management	€/MW	250,000	300,000	200,000
Generating device supply	€/MW	2,000,000	5,000,000	1,500,000
Balance of plant supply	€/MW	1,250,000	1,500,000	1,750,000
Installation	€/MW	500,000	1,000,000	350,000
Contingency	€/MW	400,000	850,000	380,000
OMS	€/MW/yr	150,000	400,000	125,000
Decommissioning	€/MW	300,000	650,000	225,000

Note: Assumption is early stage commercial/pre-commercial project. Costs are based on the assumptions below but there are still significant differences between proprietary technologies.

4.1 Development and project management

Key synergies with offshore wind

Tidal

- A good focus area for tidal, which needs to get devices in the water to continue down path to commercialisation.
- Synergy established with offshore wind but does have additional challenges (e.g. how marine mammals interact with turbines).
- Well developed supply chain from offshore wind that can be exploited

Wave

- Wave still generally confined to RD&D activity, but industry needs to be forward thinking and looking to get site leases as the process can take a long time.
- Can learn from tidal, which has experience of deploying commercial scale projects (e.g. Simec Atlantis Meygen project). For example the processes that are required to obtain a lease, and companies who can assist with early stage activities (e.g. carrying out surveys).
- As for tidal, can benefit from knowledge gained in offshore wind but the conversion of kinetic to electrical energy is more complex.

Floating

- Can utilise established processes from offshore wind.
- On cusp of commercial industry. As projects become larger, it becomes harder for SMEs to get involved without support to help them invest to enable them to achieve higher volumes.
- However, scope for SMEs to get involved demonstration projects and aim to grow with the market and project size.

Cross collaboration opportunities

- Development and project management applicable for all three technologies, hence a good area of focus.
- Tidal and wave
  - Device suppliers do not always have full range of expertise, as focussed on specific sites, so this aspect can be underestimated
  - Learning possible from open water test sites, who have experience and want to see industry succeed (e.g. EMEC, WaveHub, SEM-REV, Galway Bay)
  - Also companies who have had past success in deploying devices (e.g. SIMEC Atlantis, Orbital Marine Power, Sabella)
- Floating
  - Lower impact for OPIN resources, as commercial industry will use established names in fixed offshore wind.

4.2 Device supply

Differences between the technologies

Tidal

- Industry has largely converged on horizontal axis device, strong synergy with wind energy.
- However there are design differences and material differences, as rotors are exposed to higher loading from more energy dense resource.
- Some interest from large organisations, for example Simec Atlantis selected GE Power as its preferred supplier for its 2MW turbine

Wave

- Huge range of device concepts slows commercialisation a challenge because learning rates are slower.
- Because of the unique operating principles of different devices it is more difficult for SMEs to engage at higher level
- Some commonalities where cross collaboration would be more beneficial:
  - Point absorber is a common device class, where devices share similar operating principles
  - Some devices use turbines (oscillating water column, overtopping)

Floating

- Well established supply chain, as turbines will be the same as for fixed offshore wind.
- There are large operational projects that have used established suppliers, e.g.:
  - Hywind (Scotland): 30MW project, SGRE 6MW turbine
  - Kincardine (Scotland): 47.5MW of MHI Vestas 9.5MW turbines; planned installation 2020.
- There is sufficient market interest, using offshore wind knowledge, so less need for wider cross-collaboration.

Cross collaboration opportunities

- Tidal and wave:
  - Market volumes too low, generally not worthwhile for SMEs outside of key markets
  - Power conversion could be good area for collaboration and learning and larger companies have been involved (e.g. Bosch Rexroth in WavePod project)
  - Wave Energy Scotland would be good organisation to work with, as their projects have seen cross sector collaboration (e.g. Artemis Intelligent Power and Quoceant)
- Floating: France a key market, however generally other European countries can meet their 2030 energy targets with fixed. OPIN can help suppliers in partner countries scope out foreign markets.

4.3 Balance of plant - foundation

Important synergies

Tidal

- Fixed bottom devices: Important synergy with offshore wind, as similar materials
- Floating devices: will be synergies with floating wind and wave, with regard to anchoring and mooring systems
- Manufacturing of foundation components still at low volume, but can benefit from components that are more “off the shelf” (for example gravity foundations)

Wave

- Similar to tidal.
- As wave device capital expenditure (CAPEX) is high, there are benefits to taking simpler approaches to the foundation/mooring system.
- Early system reliability likely to be low, so could be key benefits in solutions that facilitate fast device deployment and recovery.

Floating

- Large differences with fixed offshore. While fixed wind has largely converged on monopile or jacket foundations, this is not the case for floating – where over 40 concepts are in various stages of development.
- Learning has largely come from the oil and gas industry.
- Foundations are not yet optimised. The fixed industry has tended to simpler concepts, makes sense for floating to utilise past O&G knowledge. Optimisation may be needed by technology agnostic developers or EPCI contractors
- Semi sub designs likely to have the largest market share

Cross collaboration opportunities

- Smaller floating systems could benefit from direct knowledge from similar scale maritime industries (e.g. aquaculture, shipbuilding)
- Cross collaboration between suppliers and academia could be useful for mooring system design, for example to perform quasi-static or dynamic mooring system simulations.
- Going forward manufacturing foundations in large quantities will be important, to drive down costs, so would be good to encourage collaboration in this area between device suppliers and foundation manufacturers

4.4 Balance of plant - array electrical and transmission

Dynamic cables could be good area of focus

Tidal

- Smaller projects might not require a substation and just bring the turbines to shore individually or via a junction box on the seabed.
- Floating devices will require dynamic cables, as motion of systems will put greater mechanical loads and motion cycles into cables

Wave

- Similar to tidal.

Floating

- Also require dynamic cable solutions.
- Later projects expected to be deployed in very deep water, so could benefit from cross collaboration with companies who specialise in deep sea submarine cable installation.
- Deep water projects will also require floating substations. Some companies are actively exploring this possibility, including Ideol and Atlantique Offshore Energy (in collaboration with ABB)

Cross collaboration opportunities

- Technologies will benefit from any advances made in fixed offshore wind.
- The standard array cable is a very small cost component, and established component, so would not be the best use of OPIN focus but joints and terminations could be a key area of development.
- Dynamic cables could add much values for all three technologies, from both a reliability and cost perspective, and so would be a good target for cross collaboration.
    - JDR and Nexans supplied cables for the WindFloat Atlantic project and could be useful to engage with.

4.5 Installation and commissioning

Perhaps less room for collaboration

Tidal

- Jack-up vessels used in offshore wind are unlikely to be able to operate safely.
- An advantage of floating systems is that they can be installed with smaller vessels. (for example multicats or tugs), of which there is a larger availability of locally.
- Installation is difficult because projects are built in locations with strong currents, and slack tide is needed for installation. This limited time window means faster installation procedures are desired.

Wave

- Similar issues to tidal stream, although wider weather windows will be available.
- Lots of device concepts means lots of different procedures, which could make cross-collaboration more difficult.
- Installation in extreme wave climates also poses more problems with weather window availability. This places more importance on weather forecasting, and there could be room for cross collaboration on software solutions.

Floating

- Large floating platforms will need ports capable of handling and fabricating the structures.
- Spar buoys in particular require deep water ports
- Due to similarities with O&G platforms, floating can benefit from procedures that have been developed.
- Early projects likely to be installed in deep water locations close to shore, so lower cost and lower risk.

Cross collaboration opportunities

- For smaller systems there are collaboration opportunities for using vessels from other industries (e.g. aquaculture)
- Wave and tidal exploiting less familiar locations, so could benefit from software solutions
- For all three technologies, learning will develop naturally from getting devices in water
- Could be collaboration opportunity for examining port options for large projects, as this may be a key driver for farm location.

4.6 Operation, maintenance and service (OMS)

Challenges but room for collaboration

Tidal

- There have been limited projects installed for long periods of time, so lots of learning anticipated.
- Similarities in operating principle to offshore wind, so some learning can be made, although maintenance may need to focused in the short periods of slack tide.
- However the operating environment is significantly different, with a higher density energy resource, and so the failures seen expected to be different.
- The way that electrical components are accessed is also much different, and there is room for learning

Wave

- The variety of wave device concepts makes collaboration challenging, as each device will have its own set of challenges and problems.
- Remote monitoring systems are of interest, as reliability of early stage devices is likely to be low, and will help to reassure investors that the technology is operating consistently.
- For wave the key priority is demonstrating consistent power production and reducing CAPEX.

Floating

- Identical turbine system components and operating principle to fixed wind means that there are already established procedures in place from manufacturers
- Floating platforms are more difficult to access and transfer personnel onto. Hence would benefit from innovations in remote condition monitoring, to reduce need for access.
- Large component replacement is a significant challenge
- Systems to make access easier are being pursued in fixed wind, e.g. SENSE, Limpet, and might be applicable for floating wind too.

Cross collaboration opportunities

- Test rigs: simulating thousands of cycles and operating hours. Cross collaboration between suppliers of these services and suppliers.
    - £2.4m FastBlade project (tidal blade test rig)
    - DMAC (mooring systems, University of Exeter)
    - Learning to be gained from offshore wind test rigs (e.g. blade test rigs at ORE Catapult)
- Software tools to simulate O&M procedures. Cross collaboration with software development companies and examining existing tools (e.g. ForeCoast (JBA), Mermaid (James Fisher), EOWIN (Systems Navigator))

5.1 Conclusions and recommendations

Where could OPIN add good value? Five recommendations for OPIN

Recommendations 1-3

1. **Development as an area of focus**
   - Low cost element, but applicable across all three technologies
   - Crucial to get devices in the water
   - Processes can be tricky to navigate for device suppliers/early stage developers
   - Could help inform viable project locations, crucial for minimising LCOE

   Possible collaborators: SEAI (IR), The Crown Estate (UK), SAMS (UK), Valorem (FR), MaREI Centre (IR),

2. **Software solutions for logistics/OMS**
   - Applicable for all three technologies
   - Touches on both installation and OMS
   - Could help standardise modelling approach across industries and provide third party verification

   Possible collaborators: University of Edinburgh (UK), James Fisher (UK), Systems Navigator (NL)

3. **Manufacturing**
   - To achieve competitive LCOE, all three technologies will need to take advantage of large manufacturing techniques
   - Planning the big scale vision for device manufacturing would be useful, but benefits across all technologies could be better realised through more common systems (dynamic cables, foundations, mooring systems)
   - OPIN could encourage collaboration between manufacturing facilities and device suppliers to understand where cost savings could be made, and where bespoke solutions could be displaced by more generic, low cost ones.

   Possible collaborators: Leading device suppliers, manufacturers with track record (e.g. Nexans (FR) for cables, Smulders for foundations), organisations/clusters with manufacturing expertise (e.g. Pôle EMC2 (FR))

5.2 Conclusions and recommendations

Where could OPIN add good value? Five recommendations for OPIN

Recommendations 4-5

4. LCOE analysis and data sharing

- Key challenge for all three technologies is in driving down cost and LCOE
- Being able to demonstrate competitive LCOE is also important for securing investment
- LCOE analysis can also help identify promising project locations and R&D focus
- Because device concepts can be so different within technologies, there is no consistent basis for analyses
- "Over promising and under achieving" is dangerous for the industry
- OPIN could work with organisations to understand primary modelling concerns and limitations
- OPIN could also help partner developers and device suppliers with external parties who could provide third party verification of their models and data
- Data sharing would be very beneficial to the technologies, to improve model accuracy. There have been successes with this in offshore wind, e.g. ORE Catapult SPARTA program (UK offshore wind farms)

Possible collaborators: Exceedance (IR), The Carbon Trust (UK), Wave Energy Scotland (UK), Fraunhofer IWES (DE), test facilities (e,g. EMEC (UK), SEM-REV (FR)

5. Use existing structures

- Cost reduction exercise largely driven by industry, who have best knowledge of their own strengths/limitations
- Structures have been set up to encourage joint industry projects, which OPIN could feed into or support financially

Possible collaborators: Carbon Trust Offshore Accelerator (UK), Wave Energy Scotland (UK), ADEME (FR)

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