Briefing Notes

ORE Supergen Challenge Workshop (Transformation of the ORE System)
2-3 November 2017, Plymouth, UK

R&D Challenges			
High-level	Mid-Level	MARINE WORKSHOP OUTPUTS	WIND WORKSHOP OUTPUTS
Minimising human intervention (safety)	Autonomy	Condition monitoring; Remote monitoring and fault diagnosis	Remote sensing and condition monitoring (digital twin); intelligent wind turbines and AI / machine learning with remote resets and repairs
		AUV access for inspection/maintenance	Autonomous vessels/Robotics, i.e. for monitoring of turbine and structure, environmental monitoring
		Automated/remote sensing/data collection tech / tools - for environmental interactions, integration with devices/infrastructure	Environmental monitoring technologies fully integrated in blades / infrastructure e.g. birds
		Engage existing offshore service providers to ensure they understand the purpose of autonomous / remote systems offshore (displaced employment opportunities	
			Fully autonomous farms with logistics solutions
	Control		Wind farm control and feedback
			Frequency control and power oscillation damping
			Integrated system dynamics of floating wind turbines

Improving comms/ resolving conflicts	Data/ information/ knowledge sharing / exchange	Affordable data collections systems – archiving – data mining	Data anonymity and building trust
		Early engagement/Integration of env. issues to facilitate designing out of environmental issues	Providing access, increasing availability (public)
		Uncertainty; difficult conditions, use established knowledge understanding	OEMs/Developers/Academia/regulators (e.g. consenting mammals/benthic impacts)
		Interaction with other marine users - tech/skills synergies, conflicts (planning, insurance), co-location	Improved analysis tools and treatment of big data, smarter benchmarking
		'Soft' infrastructure – local knowledge/ capability	Software sharing and curation
		Raise awareness/sharing of performance and failure for whole life cycle	Share lessons learnt, e.g. structural responses
			G+ (global offshore wind health and safety organisation)
			Regulators, OWA, ORECAT, EU, Networks etc., H2020, European academy of wind energy
	Providing reassurance / informing / educating	Public acceptability issues - communicate progress on collision risks to de risk public perceptions	Ecological impact/perception of harm - communications re for e.g. noise impacts on mammals
		Environmental considerations early to avoid conflict in consenting process	Ensuring societal acceptance/addressing public perception
		Commonality in systems, share progress	consistent language
		Run events specifically for politicians to educate at level of non-scientist	
		Ocean literacy – communication to politicians and public, education, improved understanding public engagement;	informing government better
	Training		improve training/reduce human error
			RA secondments to industry
			Upskilling workforce/addressing the shortage of people
		Ensure diversity and early career opportunities	Attract skilled researchers
		Need whole system CDT - PhDs with hybrid skills	CDT for ORESupergen

Reducing uncertainty/ risk	Better data/ understanding	Detailed measurement of the ocean over time (velocity, waves, turbulence); resource variations, extreme events	Better measurement/forecasting/characterisation of resource/MetOcean, i.e. wind @ 100m, influence of land, accessibility forecasting, extreme event prediction etc.
		Risk - reliability	Cyclic loads on foundations/soils
		Standardised approaches to environmental monitoring across sectors with national data sets	Operational limits of devices, i.e. size limitations of turbines, fatigue damage
		Resolve environmental impact uncertainties	Biological impact: birds, mammals, benthic (cabling)
			O&M uncertainties: risk based approaches to minimise risk
		Marine system carrying capacity	System carrying capacity - Limit of UK coastal waters to accommodate offshore wind; environmental limits
		Cumulative/in combination effects - better prediction and detailed monitoring overtime	Industrialisation of offshore - far field and cumulative effects - 'in-combination' effects
		Evidence for collision risk - further develop tech.	Improve collision risk models (for birds/moving wind)
			Dynamics/system stiffness of moored systems
			Better understanding of wakes (wind)
			Reduce risks of consenting - cheaper, more rational
	Reducing policy uncertainty	Route to market (tidal), needs policy framework, gov't and public support	Clear vision and policies for 2050, endorsed by gov't, informing policy and public
		Political will – 'need a political champion' who is open to learning the opportunities presented by the offshore industry (learn from wind)	
	Reducing financial risk	Impact of failures on investor confidence	Confidence in returns on investments
		Valley of death – no support to commercialise	
		Reduce uncertainty of LCOE prediction; £/kWh – overall system modelling	Providing reassurance to investors/confidence in returns
		Return on investment - expectations of investors	
	Public acceptance / perception	Environmental considerations early to avoid conflict/consenting issues	Aesthetic impacts of turbines close to shore - consenting risk and impact on development schedule
		Impact of poor ocean literacy on perception	
		Lack of confidence – in technology, public perception and awareness, impact on investors;	

Innovation (in design/ methods)	Improved design (cost effective)	Novel concepts for wave and tidal devices	Structural design/structure of wind turbines
		Novel PTO and control system for wave - control systems for wave to improve yield and survival	Improve reliability of electrical power conversion systems (all components)
		Design for through life performance with reliable components, balance among device properties, control strategies and PTO properties	Cable life
		Yield optimisation; blocking and efficient arrays in real channels	
		Moorings & foundations; coupling mooring analysis and hydrodynamics for OW / W devices; multi devices per foundation	Mooring systems and cost reduction of mooring components
		Structured innovation for wave technology	
			Floating wind - safe, economic, reliable, how to build? How do we get energy out? Spar vs. TLP
			Multi-rotor design for wind turbines
			Larger wind turbines (20MW+)
		Multi-device in one system (MPP)	Hybrid systems/Multi-purpose platforms (MPPs)
			Vertical axis wind turbines (VAWTs),Fault tolerant modular designs, Airborne wind & PTO
		Reduce cost of all components (i.e. some from O&G - over engineered)	innovative subsystems and components
			Power transmission alternatives, e.g. HVDC, and connection to shore - cost effective/reliable
	Better/ alternative materials	Low carbon materials (whole life-cycle / fit for purpose in ocean environment – marinisation of components; resilience, corrosion, degradation, protection etc. e.g. Fouling on joint sensors	Better materials for wind turbine blades, alternatives for floating e.g. concrete
		Combined coatings / materials vs biofouling	Anti-corrosion (protecting assets)
	Better manufacturing methods	Replaceable components; innovative manufacturing process for modular systems	Additive manufacture with bespoke material

	Better design methods	Modularisation / streamline manufacture to minimise (high risk) offshore activities; reducing cost of deployment); new concept to combine device into one system	Probabilistic design
		Technology convergence to follow markets/opportunities; convergence of components/ whole systems; component consolidation for wave	Wind farm analysis and design tools
	Numerical modelling	Hydrodynamic interaction for support platforms of devices; hydrodynamics and aerodynamics FSI	CFD - Fully coupled FSI/ 3 phase flow (air, water, solid)
		Efficient numerical models for array optimisation; optimal control of wave arrays; understanding device conditions for an array; hydrodynamic interaction in array systems; uncertainty quantification	Fully integrated/coupled design tools, i.e. wind, wave, current, structure
		Numerical models – understanding of best practice, error, assumptions (better use, reduced risk, reduce LCOE); system based numerical modelling	cheaper methods for resource assessment (virtual MET mast)
			Improved geo-tech modelling
		Extreme loads vs. operation behaviour; lifetime loadings / fatigue; understanding localised environment conditions to inform aggregated effects (e.g. on fatigue); modelling/prediction of extreme/'strange' environmental loads	Extreme events
		Understanding scaling effects – move towards larger scale modelling or field experiments	Wake modelling (wind)
	New management strategies	Joint / community ownership models (as on land)	
	New financial / commercial models	Innovative finance mechanisms; development grants for technology and challenges, generation subsidy	Finance/commercial management/models

Identifying opportunities	Cost reduction	Structured plan to reach acceptable COE and lower risk (sector wide) – UK benefit, needs to be in global context, potential to reduce LCOE	Optimisation of O&M through integration of methods/tools
		Cost reduction - but gap between industry and academia because of REF and application	
		Cost optimisation on both CAPEX and OPEX	
	Identifying market opportunities	New markets (small scale, non-grid connected); scope for multi-purpose projects, to fill valley of death with gov't / policy support	Alternatives to jack-up barges
	Socio-economic opportunities and benefits	Means to maximise the benefit for the UK (with Brexit uncertainty)	Awareness of markets
		Development of social capital/well-being from employment, identity and cultural aspects i.e. benefits beyond low carbon electricity - analyse salient factors e.g. 'Orkney-story'	Community owned projects; integrated community ownership/joint ventures (JVs) with energy companies
		Need a route to market for wave and tidal - no policy framework need sustained support for industry and expectations managed	Clear vision and policies for 2050, endorsed by government, informing policy and public to bring forward large installations which recognise wind as major contribution to energy system
	Recycling / relifing		decommissioning - recycle, reuse, repair, repower
			recyclable wind turbine blades
	Environmental benefits	Design in environmental benefits (e.g. de facto MPAs), decommissioning, reef effect - X-sectoral engagement; wider use of systems based modelling tools, GES;	Strategic approach to design including cabling to reduce impact on environment or design in benefits - to minimise industrialisation of offshore - co location aquaculture / MPAs etc.
		Interaction with other marine users - technology / skills synergies, conflicts (planning, insurance), co-location	
			Quantify environmental benefits, i.e. restoration, feeding into CSR, carbon accounting

	Knowledge exchange opportunities	Ensure two way communication and results communicated in understandable format	Opportunity to share lessons in offshore wind (China, Taiwan, USA)
		Non-technical summaries for all projects and case studies of challenging projects online	
		Interaction with other marine users - technology / skills synergies, conflicts (planning, insurance), co-location	
		Open innovation, open-source, community development more productive than parallel development in silos	

INTER HUB CHALLENGES
Energy storage technologies - hydrogen (safety), green ammonia - optimise (location, capacity)
Wave and wind (hydrogen based production);
All ORE types connected to power network/optimised storage/operation; off grid
Clustering/co location of different technologies for infrastructure cost savings
Offshore networks
Technologies for enabling grid compliance and smart grid networks
Manage variability and avoid curtailment of supply - flexible supply
Control systems/smart grid; integrate with energy networks, storage engineers
Integrated thinking regarding grid design
Economic power transmission to shore; grid / cost effective electricity storage at various scales;
Other infrastructure e.g. transport conduits etc.; 11kv test facilities, 33kv test facilities; quay space