Report to the

Shipbuilding Enterprise for Growth Group

by the

Centres of Excellence Task & Finish Group

In Support of the National Shipbuilding Strategy

September 2024

Contents

Executive Summary

Introduction

The Centres of Excellence Task and Finish Group (CoE T&FG) was convened to progress a recommendation from the 2022 refresh of the National Shipbuilding Strategy (NSbS). The task was to explore and enhance the role of Centres of Excellence (CoE) in enhancing the competitiveness of the UK's shipbuilding enterprise and identifying opportunities to improve productivity. This report has been developed by industry and academic experts and outlines the findings and recommendations following an extensive review and industry engagement process. This report followed the direction of the Shipbuilding Enterprise for Growth (SEG) which sponsored the CoE T&FG and includes industry recommendations for consideration by the SEG.

For simplicity, the report will refer to 'Shipbuilding' or the 'Shipbuilding Enterprise,' encompassing the SEG scope to capture the breadth, complexity and richness of the UK shipbuilding enterprise, using the definition of shipbuilding within the NSbS Refresh. The scope of the Shipbuilding Enterprise covers a wide breadth of industry across the end-to-end Shipbuilding Enterprise lifecycle from design, manufacture, build, integration of systems on platforms, test and evaluation, into acceptance; in-service maintenance support of ships and repair through to disposal; refit of vessels and in some cases conversion of existing vessels (e.g. retrofit of propulsions systems) and the end of life vessel management and disposal. From Shipbuilders and Boatbuilders to Ship Owners and Operators, Service providers, Refit & Repair Yards, Original Equipment Manufacturers (OEMs) and the wider manufacturing and technical Supply Chain content within the vessels.

It should also be noted that the writing of this report covered the change of government. The report's recommendations therefore reflect the need to focus on the delivery of positive outcomes for the Shipbuilding sector, which align with the overarching goals of the new government. In particular, we believe that the Shipbuilding Enterprise helps to deliver economic growth and clean energy, resilience and support the Strategic Defence Review 2024-2025.

The work of the T&FG recognised where a number of Centres of Excellence already exist in the UK, and also identified where there are capability gaps. This led to the CoE T&FG making the following recommendations.

Recommendations

The report identifies functional and opportunity-based recommendations to unlock the potential of CoEs to drive innovation, collaboration, and competitiveness across the UK's shipbuilding enterprise and broader maritime sector. In an increasingly unstable world, the recommendations in this report can also significantly enhance the UK's broader maritime resilience.

In the spirit of providing direct feedback from contributors, recommendations can be directly traced back to Roundtable discussions. It is recognised that some recommendation overlap; during the implementation phase, there could be some work to rationalise recommendations and how they fit together. Where industry is recommending the establishment or delivery of a CoE body, the implementation phase should include assessment of existing bodies to take on new roles. Industrial appetite to make use of best practice and the capabilities of centres of

excellence enabled by appropriate behaviours will be essential to the industry transformation that the recommendations listed is underpinning.

Recommendation Theme 1: Better Organisation for Centres of Excellence

- Identify a single body to connect and guide CoEs.
- Develop a CoE Digital Directory.
- Promote collaborative behaviours and standards.
- Promote collaborative models.
- Create a Playbook for CoE Best Practices.

Recommendation Theme 2: UK Transition to Net Zero

- Establish a Shipbuilding Enterprise Net Zero Overarching Body, to coordinate national efforts towards net-zero (Green House Gas (GHG) emissions.
- Develop a Green Technology Federation to align efforts and avoid duplication across CoEs, with a scope that would focus on alignment and collaboration and implementation of established best practice.
- Address specific gaps in existing CoEs by:
    - Creating a CoE for Shore Infrastructure Development to enhance understanding and development of shore infrastructure for net-zero targets.
    - Establishing a CoE for the Retrofit of Existing Platforms to accelerate the retrofit process of current shipbuilding enterprise platforms.

Recognising existing initiatives that are in place, it is proposed that discussions are initiated with the Clean Maritime Council about taking on this role to streamline and focus initiatives.

Recommendation Theme 3: Research and Innovation Institute

- Establish a ‘Research & Innovation Institute' to:
    - Create a National Research and Innovation Development Roadmap for the Shipbuilding Enterprise.
    - Become the national custodian of the research and innovation strategy vision for the Shipbuilding Enterprise.
    - Provide thought leadership, coordination and innovation strategy role & pipeline plan.
    - Provide nationally recognised thought leadership with respect to major imperatives.
    - Convene and engage the UK Shipbuilding Enterprise Academic, Industry, RTO, Research Institutions and Government network in collaboration
- Make the UK Innovation Network operate for the Shipbuilding enterprise, leveraging private & public funding to avoid the need for new capital-intensive projects. Ensure funding for research and innovation aligns with national strategic needs
- Signal investment in a commercial pipeline of R&D projects and prototypes coming through for investment into fully scalable and commercial solutions to drive growth.
- Establish mechanisms to monitor and evaluate the effectiveness of research and innovation activities.

The Research and Innovation Institute could be delivered by a number of existing entities which should be enhanced to drive long term research and innovation. In the implementation phase,

this will require further investigation into organisations that already exist and conduct an evidenced-based decision-making process. Responsible government bodies should engage with existing organisations (to understand scope for enhancement and capitalise on the existing body of work) including Maritime Research and Innovation UK (MarRI-UK), and the Catapult Network. The enhancement of an existing body could include becoming a community of practice activity as an overarching body to provide scrutiny, governance and accountability. Proper analysis of commercial and management options should be undertaken.

Recommendation Theme 4: Future Platform Power & Propulsion

- Create a working group to develop a collaborative strategy and roadmap for future power and propulsion capabilities, leveraging net zero / clean maritime initiatives. Develop a cohesive capability or technology development agenda for the UK shipbuilding enterprise and its export opportunities, for both retrofit and new build requirements.
- Identify opportunities to accelerate progress or develop intellectual property (IP) in next-generation prime movers (such as engines or turbines) and energy devices, supported by a net zero-focused CoE.

Recommendation Theme 5: Shipbuilding Skills

It is recommended to utilise the newly formed SEG Shipbuilding Skills Delivery Group (SSDG) as the lead to co-ordinate and drive Bodies within the Shipbuilding Enterprise in Skills Development.

The following feedback has been shared with the NSO Skills Delivery Group representative to share with the Delivery Group:

- Develop a skills sharing workforce – Create pools of regional mobile workforce to assure shipyards of labour supply.
- Develop a pool of mobile labour/technical skills – Provide a mechanism through which companies, particularly SMEs, can access specialist skills and services.
- Develop a Green Skills Pool – Grow skills in emerging technologies and clean maritime development.
- Increase diversity in the sector, particularly female participation in the shipbuilding enterprise.
- Increase links between the education sector and local industry, maximising centres of excellence to positively impact skills development.
- Increase the role of Trade Associations to support generic business skills training availability.
- Maximise Centres of Excellence to become providers of skills.

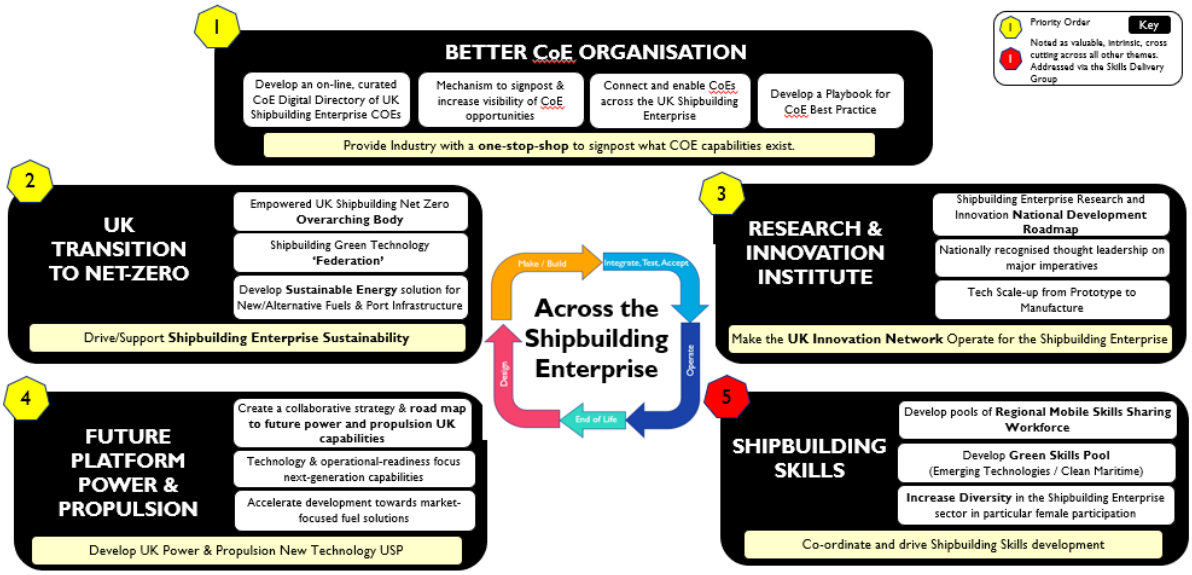
Additional recommendations

A number of additional recommendations were identified during the work and are covered in Chapter 8. These are discussed but do not feature specific key recommendations on CoEs.

Conclusion

The following provides a summary of recommendations findings from industry engagement.

NSbS Centres of Excellence –
Industry Gap Analysis Key Recommendation Summary Themes



In conclusion, the Task set by the SEG is complete. It is recommended the SEG endorses the CoE Recommendations and addresses the implementation of the CoE recommendations.

The SEG should consider the construct to drive delivery of the CoE T&FG recommendations. To inform CoE delivery phase considerations, discussions within the T&FG highlighted the need for a phased delivery approach which would allow a scaled and manageable action plan using pathfinder projects aligned to the 30-year shipbuilding programme. The feedback from industry should also be used as industry evidence to support future Comprehensive Spending Review bids. If recommendations are accepted, the scope of the strategic business case should be developed in conjunction with industry, academic and government stakeholders.

CHAPTER 1: SETTING THE SCENE

The 2022 refresh of the National Shipbuilding Strategy articulated a vision for the UK shipbuilding sector to emerge as a global leader in shipbuilding innovation, sustainability, and competitiveness by 2030. The NSbS Refresh stated that: by 2030, the UK will be at the forefront of the technological and environmental innovations driving the sector and globally competitive in the design, build, integration, test and evaluation, repair and conversion of warships, complex commercial vessels, workboats, green shipping, autonomous technologies and leisure vessels.

The National Shipbuilding Strategy (NSbS) introduced the need for a key forum to listen to and support the needs of Industry; this forum is named the Shipbuilding Enterprise for Growth (SEG). The Shipbuilding Enterprise for Growth (SEG) forum was established in March 2022 as the main interface between government and industry for the implementation of the National Shipbuilding Strategy (NSbS) Refresh. The SEG is an empowered interlocutor which builds on the strategic aims of the NSbS to identify priority areas of transformation and drive forward actions to deliver the vision. Through the SEG, industry can clearly articulate priorities and the specific industrial outcomes the sector wants to achieve, the development of the industrial base required to achieve this and what support is required from Government.

To this end, the SEG identified opportunities for members to work together, outside of any competitive procurement processes, to take action which will deliver tangible improvements to the shipbuilding enterprise and to realise the vision.

The SEG promotes Government and industry collaborative working to implement the National Shipbuilding Strategy Refresh and determine what further action is required to tackle barriers to growth, boost exports and grow high-value skilled jobs across the enterprise.

The SEG's initial aims and priorities were to identify actions to improve productivity and competitiveness through technology, innovation, supply chain and skills development.
The Tasking, defined by the National Shipbuilding Office (NSO)/SEG and agreed by the T&FG, was to explore proposals for Centres of Excellence and develop the model for the Shipyard of the Future. It was crucial to consider Centres of Excellence that would benefit the entire sector and help the UK compete internationally. It would be important to keep a time horizon beyond 2030 on this work to ensure analysis of future needs. It was recognised that the first step was to formulate the right question on what the Centres of Excellence need to achieve, linked back to the NSbS vision, before developing potential answers. The concept was to identify where Centres could foster areas of national excellence and competitiveness as well as collaboration.

To help improve the competitiveness of the UK Shipbuilding sector, it was recognised that Centres of Excellence could help improve innovation, competitiveness and productivity, identify opportunities for collaboration, and determine where investment can be shared and co-ordinated to consolidate elements of the shipbuilding value chain.

Following the publication of the NSbS Refresh and dis-establishment of the Maritime Enterprise Working Group (MEWG), a Task and Finish Group was created to take forward this work under the auspices of the National Shipbuilding Office's Shipbuilding Enterprise for Growth. The CoE Task & Finish Group is comprised of industry and academic representatives from across the Shipbuilding Enterprise Sector and is supported by the NSO; the group is led by industry – delivering for industry. The Group has been working for over two years, with all members being

volunteers who conduct their CoE work in addition to their normal duties within their respective organisations.

A list of CoE T&FG members and their experience can be found in Annex 1.

The Group established a set of objectives, vision and key definitions.

Objectives of the CoE Task and Finish Group

- Develop an organisation and structure to deliver the vision statement for CoE aligned with NSbS refresh.
- Identify where the UK industry and CoE initiatives support the overall strategy and where gaps exist in provision.
- Engage with industry and respond to developments elsewhere from the NSbS (e.g. UK Shipbuilding Skills Taskforce).
- Develop options to enhance collaboration across the sector including by focusing on tools and processes for joint working.
- Developing strategic and actionable recommendations to optimise the provision, effectiveness and integration of CoEs within the enterprise.

Vision

The UK's uniquely integrated network of Shipbuilding Centres of Excellence (CoE) will contribute to the delivery of the vision for the shipbuilding enterprise, by optimising the production of key systems and shipbuilding processes.

Definitions

To assist the work the T&FG developed two definitions with a supporting objective:

Centre of Excellence (CoE)

Definition: A Centre of Excellence (CoE) is a team, a shared facility (physical or virtual) or an entity focused on innovation and delivery by providing leadership, sharing best practices, conducting and sharing research, demonstrating capabilities, and offering support and/or training for a focus area of the shipbuilding enterprise.

Objectives

Develop options to enhance collaboration across the Shipbuilding sector including by focusing on tools and processes for joint working.

Centre of Expertise (CoExp)

Definition: A Centre of Expertise (CoExp) is an organisation or a facility, focused on innovation and delivery by providing management, displaying best practices, conducting research, delivering capabilities and training, for a focus area of the shipbuilding enterprise.

Objectives

Develop proposals to enhance existing and deliver new innovative services and products across the Shipbuilding sector by focusing on tools and processes for commercial exploitation.

Key Outputs:

1. Conduct CoE industry engagement to support a CoE Gap Analysis – Identify desired CoEs from industry engagement of the existing Centres of Excellence and analyse the demand from the breadth of the UK Shipbuilding enterprise sector. The main objective is to identify where the UK industry & CoE initiatives support the overall NSbS strategy and where gaps exist in provision.
2. Provide a Toolkit/Playbook for CoE establishment and operations.
3. Launch a CoE Digital Directory for stakeholders to access and utilise. Stakeholders would range from small, to medium and large organisations as well as government bodies.
4. Make CoE Recommendations to the SEG - Facilitate connections between existing CoEs; Provide Signposting & Visibility of Opportunities; Provide Leadership, guidance & best practice.

Defining the Shipbuilding Enterprise

The scope of the Shipbuilding Enterprise covers a wide breadth of industry across the end-to-end Shipbuilding Enterprise lifecycle:

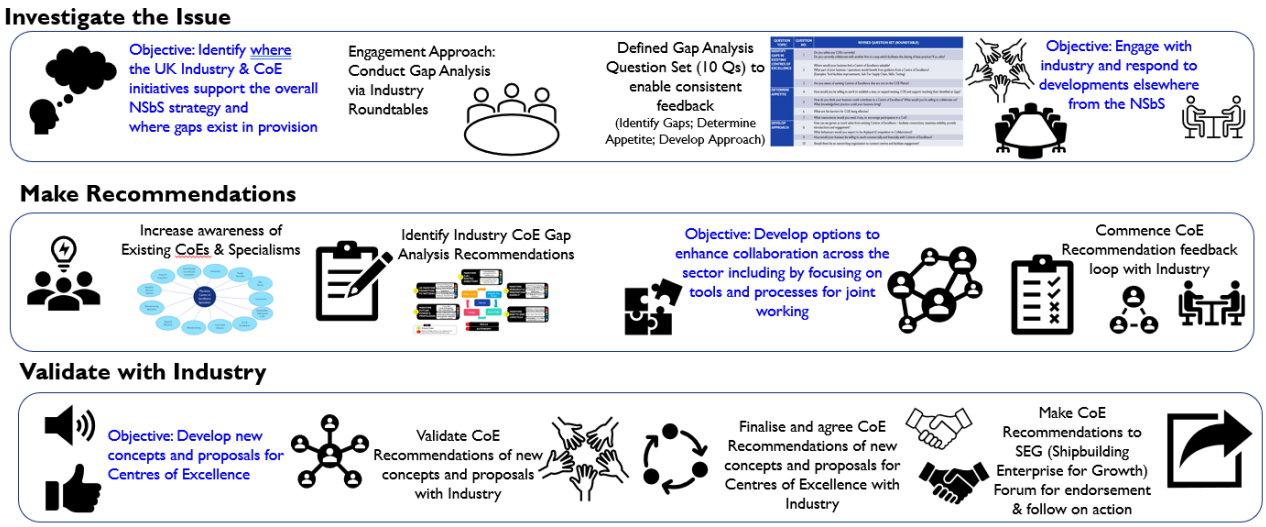
- Design
- Manufacture
- Build
- Integration of systems on platforms
- Test and evaluation, into acceptance
- In-service maintenance support of ships and repair through to disposal
- Refit of vessels and in some cases conversion of existing vessels (e.g. retrofit of propulsions systems)
- End of life management and disposal.

The 'Shipbuilding Enterprise' refers to the wider enterprise to ensure the scope captures the complexity and richness of industry, following the definition of shipbuilding within the NSbS Refresh. From Shipbuilders, Boatbuilders, Ship Owner and Operator, Services, Refit & Repair Yards, Original Equipment Manufacturers (OEMs); including the wider manufacturing and technical Supply Chain content within the vessels; for example, systems/sub-systems/and key components of the Supply Chain.

The sector is across defence and security; commercial vessels; workboats; leisure vessels; cruise, marine science, fishing, aquaculture and offshore renewables vessels.

The CoE T&FG Approach

The following provides a pictorial view of the planned approach, activities and engagements undertaken by the CoE T&FG. Based on the original tasking defined by the NSO/SEG to explore proposals for Centres of Excellence, the picture shows how the team initially investigated the issue, engaged across industry to gather feedback to then take these findings and develop recommendations. The important aspect recognised was the validation with industry to ensure the recommendation concepts and proposals reflected the discussions.



CHAPTER 2: WHERE WE STAND TODAY

Aligning UK Centres of Excellence with the National Shipbuilding Strategy Refresh

To ensure alignment of the group's work with the National Shipbuilding Strategy Refresh (Refreshed NSbS), an analysis of current CoEs was conducted within the framework of the strategy's identified drivers.

Analysis of existing UK Centres of Excellence in the Shipbuilding Enterprise

The UK benefits from an extensive network of organisations serving the shipbuilding sector. This network includes both organisations primarily focussed on shipbuilding, and those supporting a broader, cross-sectoral industry base.

As a member of the CoE Task & Finish Group, the University of Strathclyde led efforts to identify and assess the current landscape of Centres of Excellence and Centres of Expertise within the UK. This was undertaken in two phases:

- **Phase 1:** Based on a list of candidate entities (organisations, regional clusters, consortia etc) identified by the Task and Finish Group members.
- **Phase 2:** Extended the list to include additional entities suggested through Roundtable engagements.

The analysis had the following aims:

- **Map the UK Shipbuilding industrial landscape:** Identify organisations that might be considered Centres of Excellence and Centres of Expertise
- **Categorise the candidate organisations**: Based on their relevance to NSbS Shipbuilding Specialisms and themes emerging from Roundtable sessions (see diagram)
- **Assess the candidate organisations**: Using a structured methodology aimed at assessing 'excellence'
- **Use the excellence assessment to identify:**
  - Areas of national strength
  - Gaps in the current provision
  - Readily attainable mechanisms for improvements in the 'excellence' of individual entities and the overall landscape

At the end of Phase 1, the findings provided a starting point for Roundtable discussions on the current UK provision of CoEs. Upon the conclusion of Phase 2, a data set was produced for handover to NSO at the end of the Task and Finish Group's activities for follow-on work and execution of recommendations.

It is worth noting that no attempt was made to develop an exhaustive list of all actors in the UK Shipbuilding supply base. MarRI-UK have estimated that as many as c.10,000 UK entities supply the maritime sector in some capacity (based on the web search). They have also identified a stakeholder list of approximately 900 entities with some interest in maritime innovation (based on networks, funding proposals, and maritime events participants). It is estimated that around 300-400 organisations are members of UK maritime trade bodies, such as Society of Maritime Industries (SMI), UK Chamber of Shipping, British Port Association, etc. Given the Task and Finish Group's focus on Centres of Excellence (as opposed to general suppliers), a more pragmatic approach was taken to develop a list of candidate CoEs:

- **During Phase 1:** Task and Finish Group members proposed a list of candidate organisations, which were then systematically assessed for 'excellence'.
- **During Phase 2:** The initial list was presented, discussed, and additional candidate organisations were added based on attendee suggestions. The scoring was not repeated at Phase 2 for reasons outlined below.

These entities have been collated into a 'Maritime Existing Centres of Excellence Listing Extract'. This provided an initial draft of the concept of a CoE Digital Directory, listing the:

- CoE Specialism Title
- Name of the CoE
- Host Organisation
- Lifecycle Stage affected (e.g. Concept Design & Prototype Development, Design, Manufacture, Construction, Integration, Test & Acceptance, In-service Support, Refit, Disposal)
- Summary explanation of the Expertise
- Location
- Type of CoE (Industrial, Academic or RTO)
- Access status (Open or Closed)
- URL link to the CoE.

Assessing 'excellence'

During Phase 1, candidate entities were assessed using the scoring matrix below. The matrix was developed to assess all organisation types, whether providers of expertise, physical goods, consultancy, innovation and R&D, other services, access to facilities, etc. The matrix also aimed to assess organisations tied exclusively to the shipbuilding enterprise, and those serving a broader spectrum of industry. However, through the inclusion of an 'Engagement' measure, those cross-sector organisations with strong engagement with the National Shipbuilding Strategy Refresh (Refreshed NSbS) and the wider enterprise were assessed more favourably.

The assessment matrix was based on a five-point scale from 1* to 5*, and five assessment measures. For each Candidate Entity, the overall score was determined based on the worst-case score across the five measures, and with a Level 4* or 5* assessment indicating 'excellence'. The Assessment Measures were chosen to ensure a combined view of global importance, efficacy of delivery, and alignment to the sector to be considered. Scoring was undertaken by a subset of the Task and Finish Group, selected for their broad awareness of the sector and the impact of the identified entities.

For Academic and Research and Technology Organisations (RTOs), individual groups or departments within institutions were initially listed and assessed individually. These were later combined into one line-item per institution to highlight those institutions with a breadth of relevant capability. This was enabled by the addition of text indicated in italics in the scoring matrix. This rationalisation of Candidate Entities reduced the Phase 1 list from 57 to 48. The same form of rationalisation was not applied to non-academic entities, as different divisions of these organisations are often located separately and, in some cases, distributed across the country. Maintaining recognition of different site locations was considered potentially important in identifying regional clusters.

Centres of Excellence Scoring Table

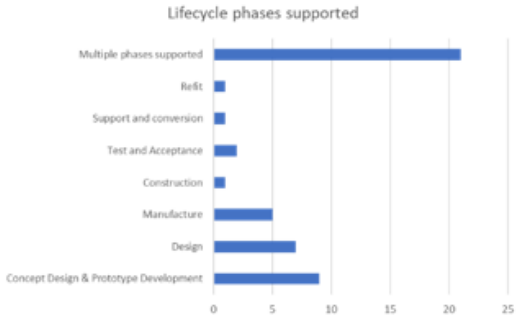
	Assessment Measures				
Level	**Global significance**	**Value add**	**Relevance of Impact**	**Timeliness**	**Engagement**
5*	Internationally recognised, leading COE in Europe/ the world, at scale, unique in UK, recognised by RAEng, etc; *(for universities, three or or more substantial research groups or areas, or one consolidated group operating across several themes, operating at this level)*	Exemplary and leading effectiveness in adding value and operating as a highly effective business partner	Many substantial examples of real business impact directly aligned to national shipbuilding including exports resulting directly from the centre	Available to shipbuilding industry now and capable of supporting full scope of demand	Fully aware of and engaged in National Shipbuilding Strategy, and accepted position in CoE listing
4*	Nationally distinct, number 1 in UK, with some international engagement; *(for universities, two or more substantial research groups or areas operating at this nationally leading, or one consolidated group operating across several themes, level)*	Highly regarded for the value of the offering and the effectiveness of partnering activity. Potential to grow to 5*	At least two independent examples of tangible business impact and direct relevance to national shipbuilding mission resulting associated with the centre	Available to shipbuilding industry now but capacity would limit full industry-wide utilisation	Fully aware of and engaged in National Shipbuilding Strategy, position in CoE listing under discussion
3*	Excellent centre, one of several in the UK; *(for universities, one or more substantial research groups or areas, or one consolidated group operating across several themes, operating at this level)*	Recognised as a value adding service and one which delivers against commitments without undue assistance	Demonstrable impact through at least one verifiable and relevant example	Available to shipbuilding industry now but capability and or capacity is limited	Named point of contact exists in centre, engagement in the goals for CoEs under development
2*	Certain important facilities or expertise;	Developing on an underlying potential to add value and becoming more independent of clients	Potential impact can be identified but probably not in the public domain or verifiable, or not specifically aligned to national shipbuilding mission	Partial capability available today. Some areas of scope under development or in planning	Discussions held with centre on Strategy and the Centre of Excellence model and their relevance
1*	Required locally, common but important and needed – eg certain HE courses.	Capable of offering a value adding service and delivery against commitments but with significant effort / support from the customer organisation	Potential for impact is apparent but not demonstrated	Under development. Active programme needs to be delivered before real benefits available	Possible awareness of National Shipbuilding Strategy

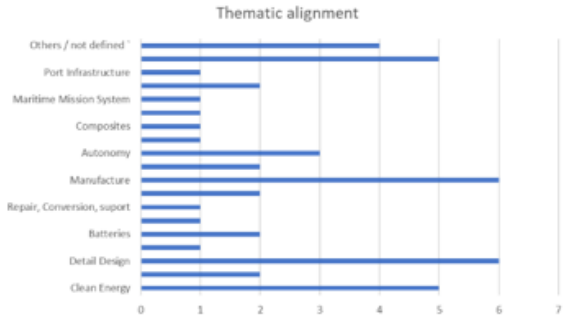
Phase 1 - Findings

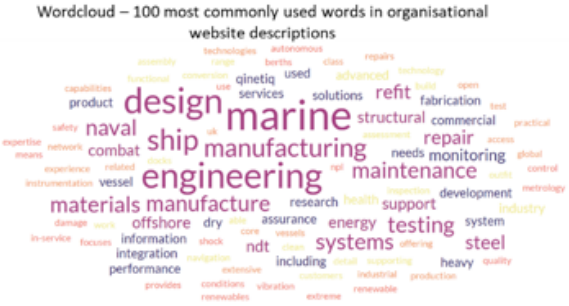
Tabulating the Candidate Entities by lifecycle phase, technical focus area, exclusivity of the relationship with maritime sectors, etc, has enabled a descriptive view of the extent to which today's landscape addresses a range of needs within the sector. The Phase One group of candidate entities covered a broad spectrum of alignment with lifecycle phases, and thematic

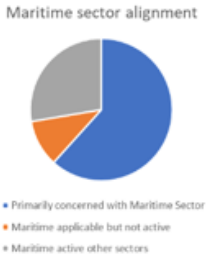
alignment, as shown below. The word-cloud indicates keywords that are used on the entities' own websites to describe themselves. Finally, we can see that that while the majority of organisations that were identified for this assessment operate primarily in maritime sectors, several have broader interests, while some others are applicable but not particularly active in maritime.

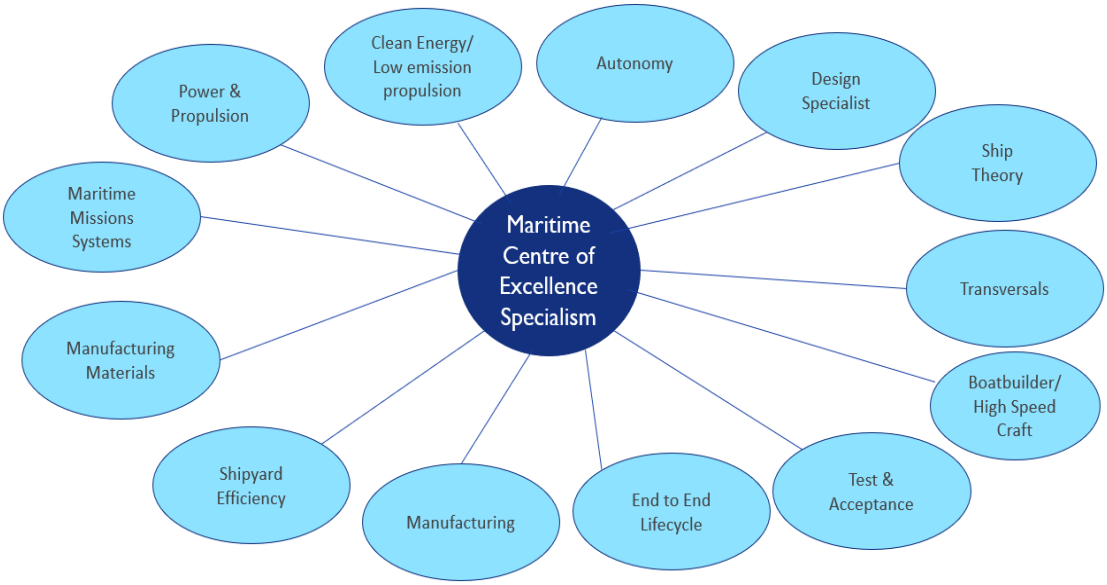
Phase 1 - High level assessment of the focus and alignment of Target Entities











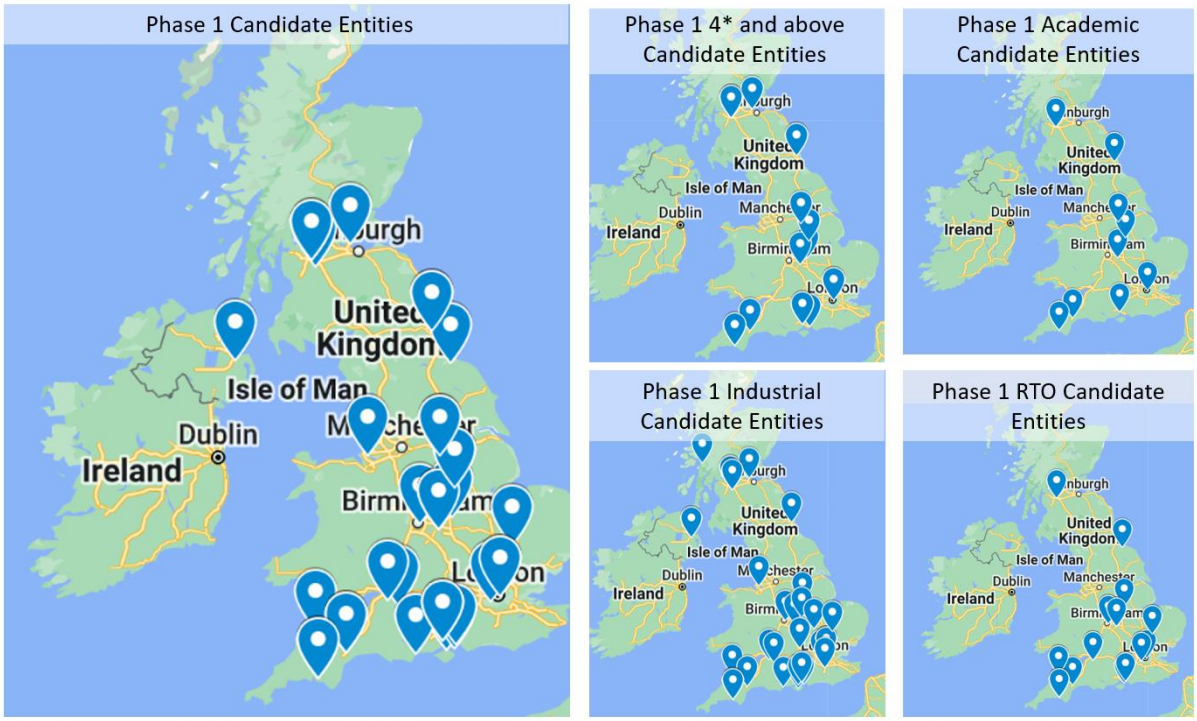
High level outcomes of the Phase 1 analysis are summarised below, split by organisation type and indicating those organisations initially assessed as 'excellent' as assessed via the scoring table. The 4* standard was clearly a relatively difficult standard to meet; however, it is important to note that the scoring system provides an indication of focused activities that would enhance excellence. For example, of those entities scoring 1*, in 73% of cases, this was solely driven by a score of 1 on 'Engagement'. Similarly in the case of 67% of 2* rated entities, that overall rating resulted solely from the 'Engagement' score. If we combine the 'Relevance' measure with that for 'Engagement' it becomes clear that 92% of low scoring entities (1* or 2*) are positioned at these levels based on a mix of alignment to the sector strategy (engagement) or demonstration of sectoral applicability (relevance).

Observation 1: This, albeit simplistic, analysis suggests that improvement in 'excellence' of the national shipbuilding landscape could be at relatively low cost via a programme of strategic engagement and involvement between target entities and the National Shipbuilding Office (NSO) in support of the NSbS. As might be expected, this was particularly evident in those organisations who are established to serve a cross sectoral customer base.

Phase 1 - Analysis Summary

The geographic spread of entities is also of interest for several reasons including clustering, outreach and the potential for developing the CoE network as a mechanism to stimulate regional economic growth. The geographic spread of entities considered in the Phase 1 analysis is sown below. As might be expected, there are clear clusters of maritime specific regions in coastal areas, notably around the Firth of Clyde, the Solent, the Mersey and North-East England. There are also several centres in Greater London. There are also a number of centres spanning the East Midlands, West Midland and South Yorkshire regions, but for the most part these are entities who serve a wider range of industry sectors with applicability to (rather than strategic focus on) maritime industries.

Phase 1 - Geographic spread of entities considered



Observation 2: It is suggested that the Phase 1 list and scoring be taken as an illustrative view of the UK landscape and as a test of the potential value that can be obtained from use of a score-based methodology, rather than as an absolute measure of 'excellence'. Any follow-up from the T&FG should incorporate a decision as to whether to develop and maintain the assessment scoring as a potential basis to target improvement.

Phase 2 - Analysis and Findings

Phase 2 primarily involved adding those entities proposed through the industrial roundtables into the review matrix. Further analysis including scoring of this larger group was not undertaken on the basis of Observation 2 above. The second phase of analysis involved a more qualitative assessment of the comments and suggestions made during the roundtables and these have been prioritised and developed into the recommendations described in this report.

Phase 2 has identified a range of additional entities for consideration. As well as a significant number of additional industrial, commercial and academic organisations, the Roundtables led to the identification of a long list of additional RTO and Partnership entities. This is perhaps to be expected given that some the more sector specific Roundtable groups would inevitably have awareness of specialist support bodies related to their activities. Several port authorities, trade bodies and government agencies were also deemed to be candidate CoE.

Phase 2 - Additional Candidate Entities identified

Industrial and Commercial Organisations

+ 7 Candidate Entities

- Rivertrace
- SAMS Enterprise – Scottish Association for Marine Science (SAMS). Includes the Seaweed Academy
- Scott Bader (experts in polymers and epoxy resins)
- Sentec consultancy (linked to Xylem Norway)
- Ecomar Propulsion
- OS Energy (an offshore service provider, clean marine)
- OXA Oxford University – Formerly Oxbotica (road)

Academic Institutions

+ 9 Candidate Entities

- Liverpool John Moores University
- Port of Aberdeen
- University of Exeter (Centre for Future Clean Mobility (CFCM))
- University of Liverpool
- University of Stirling (Institute of Aquaculture)
- Warwick Manufacturing Group - University of Warwick
- Durham University (incorporating Durham Institute of Research, Development, and Invention (DIRDI), Centre for Underwater Acoustic Analysis (CUAA), UK National Clean Maritime Research Hub (UK-MaRES))
- Imperial College London Innovation Hub
- MarRI-UK

Research and Technology Organisations & Partnerships

+ 19 Candidate Entities

- Renewables Wave and Tidal Centre (Pembroke Docks)
- Connected Places Catapult
- UK Defence Solutions Centre (part of the Defence Growth Partnership) is a related COE
- Alan Turing Institute
- CeBotIX Centre at NOC
- Digital Catapult
- EMEC – European Marine Energy Centre
- Energy Transition Zone (ETZ)
- Future Marine Research Infrastructure – Includes the Net Zero Oceanographic Capability
- HVM (High Value Manufacturing) Catapult
- Marine Business Technology Centre (advanced marine autonomy, alternative propulsion, environmental monitoring, advanced materials and cyber security. Includes the Smart Sound Plymouth)
- Marine Energy Engineering Centre of Excellence (MEECE) - Delivered by: ORE Catapult
- Marine Robotics Innovation Center recently established at National Oceanography Centre (NOC)
- National Oceanography Centre (NOC) – MARS
- National Robotarium
- Offshore Renewable Energy Catapult
- PIANC (Regulations for Ports & Terminals) - world association for Waterborne Transport Infrastructure
- Plymouth Marine Laboratories
- Plymouth Smart Sound – National Centre for Coastal Autonomy (NCCA)

Port Authorities

+ 3 Candidate Entities

- Port of London
- Port of Portsmouth
- Shoreham Harbour – Trust Harbour

Trade bodies

+ 6 Candidate Entities

- SMI - The Society of Maritime Industries (including Maritime Autonomous Systems Group, Ports and Terminals Group, Maritime Defence and Security Group))
- UK Harbour Masters Association
- UK Marine Pilotage Association (UKMPA)
- UK Port, Skills and Safety Council
- British Tug Owners Association
- Global Underwater hub

HM Government Agencies

+ 3 Candidate Entities

- UK Defence and Security Exports (part of DBT)
- UK Space Agency
- Celtic Sea Floating Offshore Wind Programme

Adding the additional entities to the list has little impact of the overall geographic spread. The Shipbuilding Enterprise is clustered around the major estuaries (e.g. Thames, Clyde, etc) and across coastal regions, supported by a significant distribution around the country across academia and the supply chain. Insight into local clusters shows Centres of Excellence were deliberately established around existing industrial specialisms in order to strengthen the links with industry.

Phase 2 - Geographic spread of all entities considered

CHAPTER 3: BEHAVIOURS AND MODELS

This chapter explores the behaviours required and models available to develop and utilise Centres of Excellence (CoEs) within the UK shipbuilding enterprise. It explores the necessary collaborative behaviours that can foster the growth and effectiveness of these centres, drawing insights from recent government policies and industry practices. Additionally, it examines various models of CoEs both within the UK and internationally.

Recommendations are summarised under Chapter 6 KEY RECOMMENDATIONS – BETTER ORGANISATION OF EXISTING CAPABILITY' on how to enhance a CoE's functionality and impact. This analysis, findings and recommendations from this work is informing the creation of a Centres of Excellence Playbook by the Connected Places Catapult.

Behaviours

The group considered the behaviour required to support and encourage the development and utilisation of Centres of Excellence for the Shipbuilding Enterprise, in particular, the report "Collaborative Working Behaviours enabling Centres of Excellence in competitive environments" (Carnie & Powell, April 23), and related NSO feedback.

Key findings:

- It should also be noted that the writing of this report covered the period of change to a new Government. The recommendations reflect the key message to focus on the delivery of positive outcomes for the Shipbuilding sector, which align with the overarching goals of the new government. These recommendations aim to support the new government's missions, strategies, policies and priorities and the impact they could have. In particular, we believe that the Shipbuilding Enterprise helps to deliver economic growth and clean energy, resilience and support the Strategic Defence Review 2024-2025.
- Over the past two and a half years, we have witnessed significant shifts in the industrial and geopolitical landscape. Domestically, a change in government has brought renewed focus on both a Strategic Defence Review and an Industrial Strategy. We firmly believe that CoEs have a vital role to play in supporting these initiatives, making our work not only relevant but our recommendations especially timely.
- Previous UK government policies, notably the Defence and Security Industrial Strategy (DSIS) and National Shipbuilding Strategy Refresh (Refreshed NSbS), advocate for a shift from competition to collaboration, aligning with international collaborative principles. These policies underpin the development of maritime Centres of Excellence, which are vital for national security and economic efficiency.
- With a history of competition, (driven by retail customers and HMGovernment monopsony in Naval sector), notably the defence sector, the UK industry supports a move towards collaborative practices within the UK shipbuilding sector, driven by both necessity and strategic considerations. Examples such as the Aircraft Carrier Alliance, Maritime UK and MarRI-UK demonstrate successful collaboration.
- The Institute for Collaborative Working highlights ISO 44000, which provides a systematic approach to collaborative business relationships. Effective collaboration requires strategic alignment, information sharing, and a focus on common values among participants.

- It was suggested that Shipyards could win contracts competitively and then opt to deliver in a more collaborative way. Some collaboration already exists at the shipyard level (e.g. in the sharing of block build of vessels, health and safety).
- Customer behaviours are required to enable collaboration and support CoE models.
- Need to understand the extent to which the shipbuilding market's appetite has been tested or analysed for, or aversion, to collaboration. It is unclear whether we must demonstrate a clear supplier demand for collaborative CoEs to influence customer behaviours.

Models

The group assessed the types of CoEs that exist in the UK and internationally within the sectors covered by the NSbS. The full output of this work will be included within the CoE Playbook.

Types of CoEs Identified:

- Research & Technology (R&T) CoEs: Focus on innovation in design, technology, materials, and manufacturing processes to improve quality and competitiveness.
- Specialist Capability CoEs: Offer unique services such as design, advanced manufacturing, and specialised engineering that may not be economically viable to duplicate.
- Integration and Test CoEs: Provide specialised services in integration and testing of systems like propulsion and safety critical systems, including standards adherence and trials.

Commercial Models for CoEs:

- Government Funded CoEs:
    - These are typically grant-funded projects aimed at addressing specific issues within the industry, potentially managed by a delivery partner
- Non-Government Funded CoEs:
    - Single Company Operated: Driven by self-investment with the aim of long-term business growth, focusing on achieving a return on investment.
    - Multi-Company Funded: Operated under agreements like a Memorandum of Understanding (MoU) or joint ventures, sharing risks and benefits among the involved parties.
    - Institution/Professional Body Led: Produces outputs for the benefit of members, potentially generating income through fees.
    - Academic Led: Funded through partnerships, with contributions from academic institutions often resulting in public domain outputs or research publications.

Centres of Excellence as Drivers of Local Economic Growth

In the UK, our Centres of Excellence are delivered by a mixture of academic institutions, public companies, research and technology organisation and privately funded specialist centres. They are often cited as a central asset in Economic Strategies as drivers of growth, by offering a space with specialist equipment, resources or acquired knowledge about a particular topic to benefit the host organisation and users of the facilities. This enables dissemination of learning or capabilities in organisations utilising them.

These additional capabilities often lead to improvements in existing products, productivity or introducing new products and services into the market, increasing market share. Organisations often choose to locate, at least part of their organisation, near or within the facilities to form longer term partnerships or service agreements with the Centres to continue to develop new ideas.

Centres of Excellence, by demonstrating their ability to drive economic growth or deliver new capabilities, act as a rallying point for collaborative minded organisations. They attract further income from funding and finance and can lead to creation of innovation or science parks with other like-minded innovative organisations and facilities.

International Comparisons

Given the importance of Centres to the development of the knowledge and skills base and economy, it is unsurprising that their importance is recognised globally. The UK enjoys strong working relationships with many other countries' maritime sectors, with established links between some of the Centres.

Major maritime nations like Norway, Denmark, the Netherlands, Germany, Canada, the USA and Singapore have world renowned Centres of Excellence, working on similar themes and in sub sectors as the UK. All of these Centres receive state funding and support in creating the facilities and in their long-term operation and ecosystem support.

In the last year, the Department for Transport (DfT) and Innovate UK have supported collaborative R&D and SME programmes in Canada and Singapore. In Canada, maritime innovation is a cornerstone of St John's Island and the naval town of Halifax, Nova Scotia. The COVE in Dartmouth (Halifax), is a research and demonstration facility associated with Dalhousie University, funded by the National Research Council and Canadian Navy and supported by a large community and series of companies operating out of the former Coastguard Station. They specialise in a wide range of marine technologies and are linked with other neighbouring facilities such as The PIER (Port Innovation Engagement Research facility). They are supported by a state funded Ocean Supercluster programme which has seen C$278M invested since 2022.

In Singapore, the Island State, which is the regulator, port owner / operator and innovation funder, has over the last decade, through its subsidiary organisations, built a large and interconnected maritime innovation ecosystem. They have four centres of excellence (port operations, safety, clean energy and maritime data / modelling) and a rolling innovation fund for SME's called PIER71. They are also co-funding with industry a substantive training facility aiming to train 5,000 operatives by 2030 in the safe handling and use of future fuels and energy systems.

DIANA is the Defence Innovation Accelerator for the North Atlantic, an organisation established by NATO to find and accelerate dual-use innovation capacity across the Alliance. DIANA has a network of more than 200 affiliated accelerator sites and test centres, covering a range of disciplines and themes in maritime, aviation and land-based tech.

There are few in the UK such as DIANA Accelerators (2024) include the Defence & Security Accelerator for the UK and DIANA Test Sites (2024) including the Battle Lab in Dorset, the National Physical Laboratory, and the Catapults for Digital, High Value Manufacturing and Satellite Applications.

CHAPTER 4: INDUSTRY FEEDBACK

Identifying gaps in CoE provision

The group recognised the importance of industry engagement to identify existing capabilities and discern gaps within the framework of the Centres of Excellence. To facilitate this, the group adopted a 'roundtable' approach for discussions, which proved effective in fostering an interactive exchange of views. These discussions were structured to not only bring issues to light but also to explore potential improvements dynamically, allowing participants to share successful practices and challenges.

The aim of these roundtable sessions was to engage a spectrum of industry representatives to refine our understanding of needs and opportunities within the CoEs. The discussions focused on three areas: i) identifying gaps in the current landscape, ii) determining the appetite for different CoE models, and iii) crafting a 'develop' approach to address these findings.

The format, which included participant briefing, discussion guides and a question framework, provided a platform for participants to influence the future direction of the UK Shipbuilding Sector and benefit from collective industry insights.

Throughout the second half of 2023, these engagement sessions drew significant participation, with over 80 individuals from nine different associations spanning various sectors of the maritime industry. These included the Society of Maritime Industries (SMI), encompassing sub-groups like the Defence MDSG Council and Commercial Marine Engineering, as well as Ports and Terminals Infrastructure, Maritime Autonomous Systems, Science & Technology sectors, and academic and research institutions through Mar-RI-UK. Industry bodies such as the Cruise Lines Industry Association, the Workboat Association, and British Marine, focusing on Leisure & Small Commercial sectors, also participated. The range of perspectives gathered through these discussions has been instrumental in providing a comprehensive understanding of the sector's needs, thereby aiding the strategic focus of CoEs tailored to meet the evolving demands of the shipbuilding industry and its associated sectors. The list of individual contributors to the Roundtables can be found at Annex 2

Engagement Results

The NSbS Task & Finish Group on Centres of Excellence engagement sessions with industry stakeholders assessed the current landscape and identified enhancements for Centres of Excellence within the UK shipbuilding industry. These discussions provided valuable insights into opportunities for growth and the existing barriers that might impede effective collaboration through these centres.

Considering the diverse needs and challenges across various sectors of the maritime industry, these sessions revealed a consensus around several key themes.

Long-terms Strategic Approach: Stakeholders highlighted the need for a strategic, long-term perspective that spans the entire maritime sector. This strategic approach should align with broader industry goals, including the National Shipbuilding Strategy Refresh (Refreshed NSbS), focusing on sustainability and adaptability to future challenges. There was significant recognition of gaps where Centres of Excellence could provide value, particularly in areas such as Maritime Net-Zero initiatives, regulatory approvals, defence exports, and skills and people development.

Clear Signposting of CoEs: Specific sector challenges were also identified. The commercial marine sector called for better guidance and support from Centres of Excellence, noting the essential role of SMEs and the need for clear signposting to leverage UK technologies and capabilities effectively. In the leisure and workboat sectors, a lack of cohesive knowledge-sharing compared to the defence sector was noted, highlighting the need for CoE structures that address the unique challenges of smaller industries.

Net-Zero: A critical need for CoEs to lead Net-Zero decarbonisation efforts was particularly noted in the cruise industry, with stakeholders pointing out the sector's lack of access to sustainable technologies compared to industries like aviation.

Innovation: The sessions also underscored the importance of fostering closer ties between industry and academia to drive innovation and maintain competitiveness in the global market.

Several barriers that could hinder effective collaboration through CoEs were discussed.

Intellectual Property: Significant concerns were raised about intellectual property, with stakeholders stressing the need for robust mechanisms to protect IP within collaborative frameworks. Companies would naturally not want to lose their hard-won Brand USPs through sharing certain areas of knowledge/skills.

Funding Models: Concerns about the sustainability of funding models for CoEs were also highlighted, particularly regarding the balance between government backing and private sector investment. Ensuring CoEs are commercially viable and attractive to industry stakeholders is seen as crucial. For SMEs (and other organisations), cost can be a barrier. Matched funding, or full government grants, would be welcomed.

Governance: Effective governance was identified as critical for the success of CoEs, with a call for transparent and accountable governance structures to build confidence in CoE management and outcomes.

Competition vs Collaboration: Historical competitive practices within the industry (driven by customers) pose a cultural barrier to embracing collaborative approaches, and changing this mindset is necessary for fostering a collaborative culture supported by strategic change management initiatives. Concerns over using CoEs in a fiercely competitive environment and CoEs potentially representing a source of anti-competitive practice.

Commercials: The right commercial wrap is important – the establishment of CoEs might inhibit agility, present barriers to new entrants, stifle innovation and exhibit anti-competitive practices – care is required.

Regulations: Navigating the complex regulatory environment, especially when developing and implementing new technologies or practices through CoEs, remains a significant challenge

The insights from these industry engagement sessions provide a comprehensive view of the strategic development needs and operational challenges of Centres of Excellence in the UK shipbuilding industry. Addressing these identified gaps and strategically overcoming the barriers to collaboration will be pivotal in enhancing the UK’s position as a leader in global shipbuilding innovation, sustainability, and competitiveness.

Establishing clear strategies for governance, funding, IP protection, and cultural transformation is essential to enable CoEs to effectively support the industry’s growth and sustainability.

CHAPTER 5: APPROACH

The Task and Finish Group's comprehensive industry engagement has identified specific market opportunities and challenges within the UK's maritime and shipbuilding sectors. These insights have led to an understanding of where demand exists for innovation and coordination. Based on these findings, the group has developed targeted recommendations to optimally address these needs.

It has considered the possible strategic response to these market opportunities and has based recommendations across three approaches. These are outlined below.

1) 'Connect/Consolidate' & Promote Existing CoEs

Many areas requiring enhancement in the maritime and shipbuilding sectors already have Centres of Excellence (CoEs) in place. However, the effectiveness of these CoEs is often hampered by a lack of coordination and visibility.

The recommendation to 'Connect/Consolidate' aims to bridge this gap by fostering increased collaboration among existing CoEs. This approach involves:

- **Enhancing Connectivity**: Establishing stronger linkages between existing CoEs to facilitate the sharing of best practices, resources, and research findings. This will create a more cohesive innovation ecosystem.
- **Increasing Visibility and Promotion**: Implementing a strategic communication plan to raise awareness of the capabilities and successes of these CoEs within the broader industry and among potential stakeholders. This would include targeted marketing campaigns, participation in industry events, and the use of digital platforms to share achievements and opportunities.
- **Monitoring and Evaluating Impact**: Regular assessment of the collaborative efforts between CoEs to ensure that the consolidation is leading to measurable improvements in innovation outputs and industry engagement.

2) 'Create' - Establish New CoEs for Identified Gaps

In cases where true gaps in CoE coverage have been identified, the recommendation is to consider the creation of new CoEs. This recommendation is critical for areas where no existing infrastructure adequately supports the strategic needs of the maritime and shipbuilding sectors. The process for establishing these new CoEs would include:

- **Assessment of Needs**: Thoroughly assessing the specific needs and potential benefits that a new CoE would bring to the sector, ensuring that the investment aligns with strategic national priorities.
- **Feasibility and Planning**: Conducting feasibility studies to determine the practical aspects of establishing new CoEs, including funding requirements, potential locations, and operational models.
- **Engagement and Collaboration**: Engaging with industry, academia, and government stakeholders to gather support and input in the planning stages, ensuring that the CoE is well-positioned to meet industry needs upon launch.

- **Integration into National Strategy**: Aligning the creation of new CoEs with broader national strategies for economic development and innovation. This includes seeking inclusion in government funding allocations, such as the Comprehensive Spending Review, to secure the necessary investments for establishment and operation.

The 'Connect/Consolidate' and 'Create' strategies are designed to effectively leverage existing resources and establish new avenues for innovation where necessary. By enhancing the connectivity and visibility of existing CoEs and carefully planning the creation of new ones, the UK can significantly enhance its competitive edge in the maritime and shipbuilding industries. These recommendations not only address current gaps but also position the sectors for future growth and alignment with global market trends and opportunities.

3) Special Project

Instead of establishing a new Centre of Excellence, set up a dedicated working group on a specific topic to investigate an individual issue in order to understand the issue and determine potential solutions. This ‘special project’ approach is to provide appropriate stakeholder engagement and collaboration to derive a proposed solution to a specific problem.

CHAPTER 6: KEY RECOMMENDATIONS – BETTER ORGANISATION OF EXISTING CAPABILITY

The CoE T&FG developed the following recommendations on how CoEs can be organised to better support delivery of the NSbS.

Theme 1: Better Organisation for Centres of Excellence

a) Identify/stand up a single body to connect and guide CoEs

- Identify a single body to connect and guide CoEs. Act as the communication channel to wider industry and society to provide a mechanism to signpost & increase visibility of CoE opportunities.
- Develop a structured organisation and governance model to deliver the vision of CoEs in line with the National Shipbuilding Strategy Refresh (Refreshed NSbS). This model should integrate various maritime sectors and facilitate smooth collaboration across the shipbuilding enterprise.
- Utilise and further develop the CoE Scoring Matrix for ongoing evaluation to regularly assess the impact of each centre. Where appropriate, support centres to progress to higher levels of impact and recognition, thus increasing their contribution to national and international shipbuilding goals.
- This single body should be empowered to deliver the recommendations identified from industry engagement e.g. 'Connect/Consolidate' & Promote Existing CoEs, 'Create' new CoEs and/or ensure the barrier or opportunity identified can be best actioned elsewhere within the enterprise ecosystem.
- This organisation should build on existing organisations or stand up an entity.
- Regularly convene CoEs to share work programmes, best practice and ensure opportunities for alignment are realised.

b) Develop a CoE Digital Directory

A key theme from industry roundtable feedback is to provide visibility of what CoE capabilities exist and to understand a brief description of their scope. The intention is that this will take the form of a CoE Digital Directory with the aim to provide a benefit to industry of being able to easily access a Centres of Excellence Directory – a one-stop-shop to understand CoEs (increase visibility, improve accessibility, have clear points of contact). The Directory would cover Centres of Excellence and Centres of Expertise.

- To improve the use of Centres of Excellence and Centres of Expertise, a digital directory and a playbook should be created which enables a broader network of CoE and CoExp to be developed as well as ensuring that the correct collaborative behaviours are incentivised to both government, industry and academia.
- Task the single body to create an easily accessible digital directory that lists all CoEs, their specialisms, host organisations, stages of the lifecycle they affect, and their open or closed access status. This will serve as a vital tool for industry engagement and collaboration.
- Provide a mechanism to signpost & increase visibility of CoE opportunities via an accessible, on-line curated CoE Digital Directory of Maritime CoE Listings.

- Audience will vary from Small and Medium Enterprise through to larger organisations and government departments.
- Ensure existing CoEs are connected and, consolidated to drive a CoE community of practice.
- There is a vision for the curation of a Shipbuilding Enterprise CoE Digital Directory (a longer-term service) with the scope of work including the set-up, management, maintenance, support and development of the CoE Digital Directory for the next (4-6) years. This would span the duration of 2 Comprehensive Spending Reviews to ensure support.

c) Promote collaborative behaviours and standards

- Update assessment of the shipbuilding market's appetite for, or aversion, to collaboration – and whether clear supplier demand must be demonstrated for collaborative CoEs to influence customer behaviours.
- Assess current collaborative behaviours within CoEs to align strategic goals more closely with those of the National Shipbuilding Strategy Refresh (Refreshed NSbS).
- Assess how the enterprise could enable or encourage shipyards to win contracts competitively and then opt to deliver in a more collaborative way (e.g. through Government procurement policies and Industry responses).
- Implement a change to Government approach regarding competition being the default procurement process; promote a change of Government procurement approach to tendering processes and rules to incentivise collaboration across industry. Have an open dialogue between government and industry on a case-by-case programme basis. This is reflected in the DSIS recommendations to increase collaboration in order to build national resilience, industrial capability and competitiveness.
- Assess how the enterprise could ensure collaboration at the sub-system level, across the supply chain and with SMEs.
- Conduct ongoing research to benchmark against international best practices in collaboration and continuously improve internal processes and outcomes through regular feedback and adaptations.
- Implement assessments of current collaborative behaviours and strategies within potential Centres of Excellence to identify areas for improvement and ensure they are aligned with the strategic goals of the NSbS.
- Develop and apply comprehensive change management strategies that promote a shift from competitive to collaborative market dynamics, ensuring all stakeholders are aligned and engaged in this transformative process.
- Encourage the development of collaborative skills and attributes within teams, such as strategic thinking, effective communication and ethical behaviour, which are crucial for successful collaborative outcomes.
- Consider how procurement structures could allow sufficient time to develop collaborative relationships and structures, or how stipulating delivery models could encourage or inhibit collaboration.

- Establish long-term initiatives and structures that support sustained collaboration, such as continuous training programmes, collaborative project management frameworks, and strategic partnerships with other industries and academia.
- Adopt and more broadly integrate the ISO 44000 standards within the shipbuilding enterprise and government to foster and formalise collaborative efforts. The proposed assessments and research recommendations above should be undertaken using the ISO 44000 standards. (ISO 44000 series-International Organisation for Standardisation - principles for successful collaborative business relationship management).
- Adopt and integrate other relevant ISO standards to formalise collaborative efforts within the shipbuilding industry. (e.g. ISO 56000-Innovation Management series, PAS 280-Through Life Engineering Services; ISO 55000-Assett Management series).

d) Promote collaborative models

- Establish a clear framework for collaboration among different types of CoEs, ensuring that they can effectively share knowledge and resources.
- Develop models that encourage both public and private investment, recognising that a mix of funding sources can enhance the sustainability and impact of CoEs.
- Promote standardisation and access to shared resources across the UK Shipbuilding Enterprise to ensure broad benefits from the advancements made within CoEs.

e) Develop a Playbook for CoE Best Practices

- Produce a Centres of Excellence Playbook that outlines best practices, operational guidelines, potential commercial models and success stories to guide new and existing CoEs. This playbook should also include strategies for effective collaboration and fostering of innovation.
- N.B. This work has already been started and fully paid for by the NSO. The CoE Playbook is being delivered in collaboration with Connected Places Catapult.
- The aim of the CoE Playbook is to provide a best practice guide to maximise engagement across the maritime industry to bolster the UK shipbuilding enterprise through the practical foundations of:
    a) What makes an effective Centres of Excellence (CoE)
    b) How to establish and operate CoEs
    c) How to engage with the market
- Engagements have taken place with c. fourteen existing Centres of Excellence chosen to participate
- The aim is to be able to relay a sense of community within the shipbuilding sector, across geographical and organisational differences; provide context and means to new and ongoing collaborative projects.

CHAPTER 7: KEY RECOMMENDATIONS – DEVELOPMENT THEMES

The group identified key themes where CoEs could drive substantial progress:

Theme 2: UK Transition to Net Zero

Recommended approach: 'Connect/Consolidate' & Promote Existing CoEs

The primary goal is to achieve net-zero greenhouse gas (GHG) emissions from the UK domestic maritime sector by 2050. This involves a revolution in maritime green technologies across fuels, machinery, electrical systems, propulsion, and hull forms, applicable to both new builds and retrofits. This ambitious objective requires a multi-faceted approach encompassing policy levers such as incentives through mechanisms like the Emissions Trading Scheme (ETS), legislation via acts such as the Climate Change Act, and funding allocated through programs like UK Shipping Office for Reducing Emissions (UK SHORE); Clean Maritime Demonstration Competition (CMDC), and Zero Emission Vessels and Infrastructure (ZEVI). Note ZEVI is for higher Technology Readiness Levels (TRL) & CMDC is low TRL.

The strategic rationale for these recommendations includes national coordination to ensure coherence among existing CoEs, clear regulatory guidance and certification, and the enhancement of the commercial model to support the creation and functioning of true CoEs. The Department for Transport (DfT) within the Maritime Directorate will play a leading role in policy setting, incentivisation, and national interventions, owning the flagship Clean Maritime Plan. The Department for Business and Trade (DBT) will focus on industrial policy, infrastructure investment, and advanced manufacturing, while the Department for Energy Security & Net Zero will oversee the broader energy strategy impacting maritime decarbonization. The Maritime and Coastguard Agency (MCA) will implement international maritime conventions in UK waters and Innovate UK (UKRI) will support business-led innovation relevant to maritime decarbonization.

Stakeholder engagement is critical and will involve industry associations such as Maritime UK and the Society of Maritime Industries (SMI), industry stakeholders including shipbuilders, operators, and supply chains, as well as academic contributions from various universities and research centres. The evidence base for these recommendations includes the updated Clean Maritime Plan ('Voyage to Net Zero'), the Maritime Decarbonisation Strategy 2022, and reports on funding mechanisms and investment mobilization for the net-zero transition.

After considering various options for intervention, the recommended action is to adopt minimal intervention by creating an overarching body and federation to ensure coordinated and coherent national efforts. This approach should be supplemented by targeted Centres of Excellence for shore infrastructure and retrofitting existing platforms, thereby providing the necessary framework to achieve the net-zero GHG emissions goal for the UK domestic maritime sector by 2050.

Recommendations

- To achieve net-zero (Green House Gas) GHG emissions, the establishment of a Net Zero Overarching Body is essential to coordinate national efforts across the Shipbuilding Enterprise.
- Additionally, a Green Technology Federation should be developed to align efforts across various Centres of Excellence (CoEs) and avoid duplication. With a scope that would focus on alignment and collaboration and implementation of established best practice.

There are specific gaps in the existing Centres of Excellence that need to be addressed:

- A dedicated Centre of Excellence for Shore Infrastructure Development should be established to enhance understanding and development of shore infrastructure to meet net-zero targets.
- Similarly, a focused Centre of Excellence for the Retrofit of Existing Platforms is crucial to accelerate the retrofit process of existing maritime platforms.

Recognising existing initiatives that are in place, it is proposed that discussions are initiated with the Clean Maritime Council about taking on this role to streamline and focus initiatives.

Theme 3: Research & Innovation Institute

Recommended approach: 'Connect/Consolidate' & Promote Existing CoEs

The primary recommendation is to establish a 'Research & Innovation Institute'. This institute would serve as the focal point for coordinating research and innovation activities across the UK shipbuilding enterprise. Its core functions would include ensuring that public funding for research and innovation aligns with national strategic needs, facilitating the involvement of industrial participants in research initiatives, and maintaining a comprehensive research and development roadmap for the maritime sector. Additionally, it would enhance connectivity among existing Centres of Excellence (CoEs) related to shipbuilding and maritime sectors, including aligning generic CoEs with national needs, bringing together the UK Shipbuilding / maritime academic network to foster collaboration, and establishing mechanisms to monitor and evaluate the effectiveness of research and innovation activities.

Feedback from industry roundtable events indicates a lack of coordination among the numerous CoEs supporting the Shipbuilding Enterprise / maritime sector. Many CoEs are underutilised due to misalignment with the NSbS. A coordinated approach, leveraging existing public funding, offers significant value without the need for new capital-intensive projects. Currently, there is no effective communication channel for national shipbuilding R&D and innovation needs, leading to strategic issues being overlooked. Furthermore, funding decisions are often based on academic criteria rather than strategic needs, causing misalignment with industry priorities.

The Research and Innovation Institute recommendation aligns with the ambition of enhancing productivity and competitiveness within the maritime and shipbuilding sectors. By providing a permanent solution to innovation challenges, the institute would significantly contribute to the UK's ability to enhance productivity and competitiveness goals. The initiative has broad industry support and promises to foster stronger collaborative working among existing CoEs, maximizing their impact.

While short-to-medium-term innovation support programs are currently in place, other sectors have established more permanent organisational structures. The Institute would address this imbalance, providing a dedicated, enduring framework to support innovation in the maritime and shipbuilding sectors.

Establishing a Research & Innovation Institute would centralize efforts, reduce duplication and ensure that strategic innovation efforts align with national needs. This institute would streamline existing resources and enhance the UK's position as a leader in maritime and shipbuilding innovation.

Recommendations:

- Establish a 'Research & Innovation Institute' to:
    - Create a National Research and Innovation Development Roadmap for the Shipbuilding Enterprise.
    - Become the national custodian of the research and innovation strategy vision for the Shipbuilding Enterprise.
    - Provide thought leadership, coordination and innovation strategy role & pipeline plan.
    - Provide nationally recognised thought leadership with respect to major imperatives.
    - Convene and engage the UK Shipbuilding Enterprise Academic, Industry, RTO, Research Institutions and Government network in collaboration
- Make the UK Innovation Network operate for the Shipbuilding enterprise, leveraging private & public funding to avoid the need for new capital-intensive projects. Ensure public funding for maritime research and innovation aligns with national strategic needs.
- Signal investment in a commercial pipeline of R&D projects and prototypes coming through for investment into fully scalable and commercial solutions to drive growth.
- Establish mechanisms to monitor and evaluate the effectiveness of research and innovation activities.

Theme 4: Future Power & Propulsion

- Create a working group to develop a collaborative strategy and roadmap for future power and propulsion capabilities, leveraging net zero / clean maritime initiatives. Develop a cohesive capability or technology development agenda for the UK shipbuilding enterprise and its export opportunities, for both retrofit and new build requirements.
- Identify opportunities to accelerate progress or develop intellectual property (IP) in next-generation prime movers (such as engines or turbines) and energy devices, supported by a net zero-focused CoE.

CHAPTER 8: OTHER RECOMMENDATIONS

In addition to the key recommendation themes, there were other areas consistently identified during industry engagement and through the group's research where centres of excellence (CoE) or other interventions could help enhance UK competitiveness. These are summarised below, including recommendations which fall outside the remit of the group. For completeness and in the expectation that the Shipbuilding Enterprise for Growth (SEG) will be able to respond to, and make progress on these areas, they are included in this report.

Theme 5: Shipbuilding Skills

It is recommended to utilise the newly formed Shipbuilding Skills Delivery Group (SSDG) as the lead to co-ordinate and drive forward the skills aspect of the NSbS.

The following feedback has been shared with the NSO Shipbuilding Skills representative to share with the Delivery Group:

- Develop a skills sharing workforce – Create pools of regional mobile workforce to assure shipyards of labour supply.
- Develop a pool of mobile labour/technical skills – Provide a mechanism through which companies, particularly SMEs, can access specialist skills and services.
- Develop a Green Skills Pool – Grow skills in emerging technologies and clean maritime development.
- Increase diversity in the sector, particularly female participation in the maritime enterprise.
- Increase links between the education sector and local industry, maximising centres of excellence to positively impact skills development.
- Increase the role of Trade Associations to support generic business skills training availability.
- Maximise Centres of Excellence to become providers of skills.

Shipbuilding Enterprise End-to-End Shipbuilding Lifecycle

The UK Shipbuilding Enterprise covers a wide scope of industries engaged in the End-to-End Shipbuilding Lifecycle. This ranges from Design to Manufacture, Build, Integration of Systems on platforms; through Test and Evaluation, into Acceptance; In-Service Repair, Maintenance, Refit and Conversion; through to Disposal of ships and vessels. There is a consensus across industry of the importance of greater consideration of the Maritime End to End Lifecycle when making acquisition decisions and the potential for the UK to build strengths and recognised expertise in this area. A number of themes were highlighted that could be taken forward in future CoE activities.

- **Design –**
    - Developing innovative design capability supporting new technologies and vessel developments.
    - Cross-sector transfer opportunities from defence into complex commercial vessels to minimise environmental impact from Commercial Vessels (e.g. Reduce noise for the environment /net-zero).

- Propulsion and energy management technology and systems to promote net-zero ambitions and meet targets.

- **Manufacture –**
    - Currently UK shipbuilders have to go abroad for aluminium material supply & profiling, and there is an opportunity to improve UK competitiveness by creating this capability in the UK.
    - Three-dimensional steel plate cutting and forming is a core capability in a small number of the larger UK shipyards, but other shipyards currently get plate cutting and forming undertaken in Europe. There is an opportunity to increase the UK capacity and accessibility for steel plate cutting and forming to increase UK competitiveness.
    - Investing in manufacturing technology development to improve the scale-up from prototype to manufacturing, thereby increasing overall UK productivity and competitiveness.

- **Integration of Systems including Test & Acceptance -**
    - Encourage collaboration in integration / test & acceptance cross sector transfer opportunities.
    - Provide specialised services in integration and testing of systems on platforms (e.g. propulsion and safety-critical systems), including standards adherence and trials.
    - Proven, cost-effective models for undertaking these integration, test, evaluation and assurance activities ashore exist for power & propulsion, sensors, communications and combat systems. The capabilities at GE Vernova's Maritime Propulsion Test Facility and Portsdown Technology Park use a sophisticated blend of facilities, synthetic test and emulation environments, tools, processes and highly skilled engineers. These capabilities provide an integrated system-level approach, to minimise the demand and cost of sea trials and can accelerate and de-risk the path to operational capability.

- **Repair and Maintenance -**
    - Through life support is a key capability across the UK. However there is scope to increase the level of repair and maintenance facilities available to the UK Cruise Line business, particularly in Southampton.

- **Refit & Conversion** –
    - Potential exists to develop capability in commercial refit, repair and retrofit of new technologies onto current platforms including Net Zero Green technologies and new propulsion systems.
    - This would need to be supported by infrastructure investment to attract more vessels to yards, facilitate dry docking of larger vessels.
    - Many leisure boats are in need of refurbishment and could be successfully extended in life, through greater investment in this area.

- **Disposal** –
    - Develop a cleaner approach to end-of-life disposal of vessels in the UK, recognising their impact on the coastal environment.

- Create a UK strategy for Sustainable Vessel End of Life Policy & Disposal (noting in particular, GRP (Glass Reinforced Plastic)/abandoned boats). This would be achieved by:
- Encouraging a collaborative approach to bringing together policy makers, manufacturers, academia & communities to develop new policies for End-of-Life disposal, boat registration or levies)
- Create a Composites recycling plant in the UK. This would gather composite waste from around the country, de-construct the composite elements and re-purpose the non-structural composite items.

Other Roundtable Discussion Topics

The following summarises several topics discussed during the CoE Roundtable discussions. These are recognised as important topics but are not taken forward as Key Recommendations for the activities of this CoE Task & Finish Group.

- **Maintaining a UK Sovereign Assured Defence Capability** - to contribute to national security, collaboration with other nations for export potential

- **Maritime Autonomous Systems** - it was noted from the Industry Roundtables that there is a plethora of Centres of Excellence in the Autonomy space. Collaboration in the autonomy world is common and indeed essential. There are excellent examples of Centres of Excellence in this speciality area. Based on feedback, it is COE signposting about how to understand the ecosystem and find trusted suppliers for both solution providers and end users that was seen as most important. Engagement with NATO was considered important and a NATO Autonomy COE suggested, although it was noted that Maritime Unmanned Systems Innovation and Coordination Cell (MUSIC^2) already exists

- **Digitalisation** – Another theme raised as a wider dependency but not addressed in key CoE recommendations is the digitalisation of individual parties in ports / shipyards; integrated systems in a maritime community; logistic chain integrated with wider networks; connected ports & shipyards in global logistics chains; ports and terminals infrastructure digitalisation & electrification management.

CHAPTER 9: CONCLUSION

The report by the Centres of Excellence Task and Finish Group (CoE T&FG) has highlighted the important role and potential that Centres of Excellence (CoEs) can play in advancing the UK's shipbuilding enterprise. Aligning with the National Shipbuilding Strategy Refresh, the recommendations aim to leverage CoEs to drive innovation, collaboration, and competitiveness, ultimately bolstering the UK's maritime resilience.

The findings stress the need to establish a structured and coordinated approach to CoE management. The proposed development of a single body to connect and guide CoEs, alongside the development of a digital directory and playbook for best practices, is crucial for enhancing organisational efficiency and industry-wide collaboration.

The establishment of a Net Zero Overarching Body for the Shipbuilding Enterprise is essential to coordinate national efforts to achieve net-zero GHG emissions. Recognising existing initiatives that are in place, it is proposed that discussions are initiated with the Clean Maritime Council about takings on this role to streamline and focus initiatives; this supervisory role should sit alongside a Green Technology Federation to align efforts across various CoE. There are some gaps in the CoE landscape, dedicated CoEs for Shore Infrastructure Development and Platform Retrofit are needed.

The formation of a Research & Innovation Institute for the Shipbuilding Enterprise is advocated to centralise research activities, align public funding with strategic needs, and foster stronger industry-academia collaboration. This institute will ensure that innovation efforts are strategically focused and effectively communicated, thereby enhancing the productivity and competitiveness of the UK Shipbuilding sector.

The industry feedback highlighted the need for a long-term strategic approach, clear signposting of CoE capabilities, and a robust framework for intellectual property protection and funding. Addressing these elements is critical to overcoming barriers and maximising the impact of CoEs.

The recommendations outlined by the CoE T&FG provide a robust framework for harnessing the potential of CoEs. They are by no means exhaustive but provide a credible foundation to better organise and target two key missions. Making progress on these will provide a roadmap for further collaborative progress on other missions.

By fostering innovation, collaboration, and strategic alignment with national goals, these recommendations have the potential to enhance the UK’s shipbuilding sector, ensuring it remains competitive and resilient in an increasingly challenging global landscape.

In conclusion, the Task set by the SEG is complete, and this group seeks SEG approval to implement the recommendations and stand down the current CoE T&FG. If the SEG agrees with the CoE Recommendations, the SEG needs to decide on the priorities and construct in which to drive delivery of the CoE T&FG recommendations. It is recommended that these topics be discussed in relevant, future Centres of Excellence in how they could be taken forward. To inform CoE delivery phase considerations, discussions within the T&FG highlighted the need for a phased delivery approach which would allow a scaled and manageable action plan using pathfinder projects aligned to the 30-year shipbuilding programme.

The feedback from industry should also be used as industry evidence to support future Comprehensive Spending Review bids. If recommendations are accepted, the scope of the strategic business case should be developed in conjunction with industry, academic and government stakeholders.

ANNEX 1 - CoE Task & Finish Group Members

Name	Experience relevant to this T&FG
Ben Murray	Chair of the NSbS CoE T&FG, established Maritime UK as its first Chief Executive, leading cross-sector campaigns and coordination, including co-designing Maritime 2050 and delivering industry led programmes on skills and regional cluster development. Later served as Chief of Staff & Corporate Affairs at Harland & Wolff.
Richard Powell	45 years' experience in the maritime sector, in both government, industry and trade associations. SMI Council Chairperson for Maritime Defence & Security Group (MDSG) and Board member.
Monty Long	37 years in maritime, both uniformed and supply side. Naval capability sponsor for original NSbS.
Rachel Connor	Over 30 years' experience working with major OEMs in strategy and commercial functions across the defence, maritime and energy sectors. SMI board member and vice chairperson.
Geoff Searle	35 years' experience in the naval shipbuilding industry, in engineering, operations management and programme leadership roles.
Patrick Carnie	Over 35 years in the naval sector (both customer & supply sides) and workboat/leisure sectors. Initial report author on 'Collaborative working behaviours in a competitive environment' and on shipbuilding CoEs for MEWG. Contribution to 2022 NSbS Refresh. Co-author Global Marine Trends 2030. Drove foundation of MarRI-UK & Scottish Maritime Cluster.
Michael Ward	30+ years' experience in the deployment of innovation, spanning industry sectors (aerospace, nuclear, energy, rail, building products, polymer processing) and through roles in industry, RTO / Catapult entities, and the academic sector.
Mark Wray	Over 30 years' experience working across major industries focused on sustainability and innovation. A commercial diver by training; spent the last 5 years working on delivering innovation led economic growth in the maritime sector. Currently working on a host of government funded maritime programmes, including Maritime Milestone, Maritime Pulse, Freight Innovation Fund, Domestic Green Shipping Definition T&F Group.
Colette Munroe	27 years in defence sector, predominantly in Supply Chain. Currently seconded into the National Shipbuilding Office from industry. Giving drive, direction & support to CoE T&FG

Original members also included Andy Mitchell (Royal Navy), Adrian Bratt (Princess Yachts), Ken Holberg (Ocea UK), Iain Percy (Artemis Technologies, and Eamonn Beirne (Department for Transport).

ANNEX 2 - CoE Gap Analysis Round Table Stakeholder Contributors

Sincere thanks to the contributors across a number of associations which supported the development of the Centres of Excellence Gap Recommendations.

Association Title	Society of Maritime Industries (SMI) Councils									
Industry representation	Defence - MDSG Council		Commercial Marine Engineering		Ports and Terminals Infrastructure		Maritime Autonomous Systems		Science & Technology	
COE Facilitator	Tim Currass	SMI/NSO/COE T&FG	Rachel Connor Tim Currass	GE Vernova/COE T&FG SMI/NSO/COE T&FG	Tim Currass	SMI/NSO/COE T&FG	Tim Currass	SMI/NSO/COE T&FG	Tim Currass	SMI/NSO/COE T&FG
No. of Contributors	16		10		6		11		6	
Association Chair	Richard Powell	QinetiQ/COE T&FG	Helen Stephen	SMI	Helen Stephen	SMI	Emma Johnson	SMI	Emma Johnson	SMI
Contributors	Mr Richard Barton	Rolls Royce	Kevin Robertson	Hamilton Jet and Chair CMG	Gordon Rankine	PTG Chair, Beckett Rankine	Aidan Thorn	Sonardyne International	Amy Thompson	Oceanwise
	Mr Paul Blakiston	Babcock International Group	Steve Hudson	GE Vernova	Tom Matthewson	HR Wallingford	Bill Biggs	QinetiQ	Darren Jones	Sonihull
	Damien Bloor	FMI/RHDHV	Julian Mason	Houlder Ltd	Phil Thompson	BMT Group	Chloe Yarrien	BMT Group	David Goldsmith	Xylem
	Iain Breckenridge	Leonardo UK	Anthony Greatwood	Eminox	Phil Banks	GE Power Conversion	David O'Sullivan	Thales	Phil Bishop	NOC
	Hannah Grier	BAE Systems Maritime	Kier Gravil	FNC	Robbie Gorman	Malin Group	Harry Spedding	Autonaut Ltd	Ryan Mowatt	RS Aqua
	Simon Harris	Houlder Ltd.	Noel Tomlinson	BMT			Kevin Forshaw	University of Plymouth		
	Ken Houlberg	OCEA UK / COE T&FG	Mike Coomber	Rivertrace			Mark Exeter	L3 Harris		
	Mr Mark Lawther	Harland&Wolff	Professor Richard Bucknall	UCL			Mark Hamson	National Oceanography Centre		
	Julian Lockett	Frazer-Nash Consultancy	Paul Edwards	MD, P&S Automation			Peter Collinson	Dendrityca Ltd.		
	Nick Macdonald-Robinson	Royal Haskoning DHV					Terry Mills	Solent University		
	Julie Martin	Thales UK								
	Tim Neild	BMT Group								
	Ben Potter	Malin Group								
	Clive Sharp	Roxtec Limited								
	C/O Stuart Smith RFA	Naval Staff								

Association Title	Mar-RI-UK		British Marine		Workboat Association		Cruise Lines Industry Association		Offshore Renewable Energy Catapult (OREC)	
Industry representation	Academic & Research Institutions		Leisure & Small Commercial (Suppliers and Operators)		Workboats (Operators and Builders)		Cruise lines (Operators)		Manufacture, integration of SOVs/CTVs	
COE Facilitator	Michael Ward	University of Strathclyde/COE T&FG	Tim Currass	SMI/NSO/COE T&FG	Monty Long	BMT/COE T&FG	Ben Murray	Harland & Wolff/COE T&FG	Colette Munroe	NSO/COE T&FG
No. of Contributors	18		6		6		1		1	
Association Chair	Dr Wenjuan Wang	MarRI-UK	Brian Clark	British Marine	Kerrie Forster	Workboats Association	Andy Harmer		Lauren Hadlam	OREC
Contributors	Paul Fehrenbach	BAE Systems	Adrian Bratt	Princess Yachts	Andrew Southwood	Siemens Financial Services				
	Eirini Trivyza	Babcock	Sean McMillan	Spirit Yachts	Charlotte Wood	Mainstay Marine				
	Richard Westgarth	BMT / MarRI-UK	Belinda Joslin	Women in Boatbuilding	Gavin Ball	Vulkan UK				
	Jake Rigby	BMT	Heidi Reynolds	Dale Sailing	Scott Baker	Svitzer Marine Ltd.				
	Anthony Bennett	Ecomar Propulsion	Tom Woods	Silverfleet	Martin Rice	CEO, Farra Marine				
	Nick Abson	Cygnus Atratus (Fuel cell developer)								
	Ed MacFarlane	Abbott Risk Consulting								
	Charlie Spencer	SPAERA								
	Tahsin Tezdogan	University of Southampton								
	Milad Armin	Liverpool John Moores University								
	Evangelos Boulougouris	University of Strathclyde								
	Ian Whitfield	University of Strathclyde								
	Chris Smith	University of Exeter								
	Yuanchang Liu	University College London								
	James McNaughton	University of Exeter								
	Andy Plater	University of Liverpool								
	Jill Rymer	MarRI-UK								

TOTAL NUMBER OF CONTRIBUTORS TO CoE ROUNDTABLES:

81

Recommendation findings presented for industry

Maritime UK- South West Breadth of maritime sector - Regional Clusters

Innovation Partners Group Made up of UK Government agencies involved with maritime innovation

ANNEX 3 – Existing Listing - Centres of Excellence/Expertise

The following provides a summary of the existing Centres of Excellence (CoE) and Centres of Expertise (CoExp) across the UK. It should be noted this listing is not exhaustive. The order is sorted by 'Name' of organisation.

N.B. A separate excel file named 'Maritime Centres of Excellence_Existing COE Listing Extract_30Jul2024' is available.

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Welding, Manufacture, construction, support	Manufacturing	A&P Tyne	A&P Group	Manufacture, Construction, Support, Refit, Conversion	Commercial ship maintenance, repair, refit and conversion. Naval ship maintenance, repair and refit. Dry Dock; Steel manufacture; Ship block build. A&P Tyne boasts the largest commercial dry-dock on the East coast of England as well as two deep water berths and a significant modern fabrication facility complete with panel line, rolling, plasma and gas burning machines. Providing world class ship repair, conversion and fabrication services across the marine and energy sectors, A&P Tyne offers extensive storage and load-out capabilities and fully equipped workshops to manage all projects from simple ship repairs to major complex ship conversions.	Newcastle, Tyneside	CoExp	Industrial	https://www.ap-group.co.uk/facilities/ap-tyne
Composites	Manufacturing Materials	Advanced Composite Materials Facility (ACMF)	University of Southampton	Concept Design & Prototype Development	Materials Discovery, device development	Southampton	CoE	Academic	https://www.southampton.ac.uk/advancedmaterials/index.page
Manufacturing technologies, R&D, and metal forming and forging research	Manufacturing	Advanced Forming Research Centre (AFRC)	University of Strathclyde	Manufacture	The Advanced Forming Research Centre (AFRC) is a globally-recognised centre of excellence in innovative manufacturing technologies, R&D, and metal forming and forging research	Glasgow	CoE	Academic	Advanced Forming Research Centre | University of Strathclyde
Design, Digital Shipyard, Machining, Welding, Composites, Process mapping	Manufacturing	Advanced Manufacturing Research Centre (AMRC)	University of Sheffield	Manufacture, Construction	Carrying out world-leading research into advanced machining, manufacturing and materials, which is of practical use to industry. With 11 core capabilities: Machining; Integrated manufacturing;Composite Manufacturing; Castings; Design & prototyping; Structural testing; Medical; Additive Manufacturing; Microscopy; Metrology; Manufacturing Intelligence	Sheffield	CoE	Academic	AMRC - The University of Sheffield Advanced Manufacturing Research Centre with Boeing
Welding	Manufacturing	Advanced Manufacturing Research Centre-Nuclear (NAMRC)	University of Sheffield	Manufacture	NAMRC: Welding R&D at the Nuclear AMRC focuses on developing advanced and innovative joining and cladding techniques tailored to the needs of the nuclear industry.	Sheffield	CoE	Academic	About our Nuclear Advanced Manufacturing Research Centre (namrc.co.uk)
Data and Artifical Intelligence	Autonomy	Alan Turing Institute	Five founding universities – Cambridge, Edinburgh, Oxford, UCL and Warwick – and the UK Engineering and Physical Sciences Research Council created The Alan Turing Institute in 2015	All	The Alan Turing Institute is the national institute for data science and artificial intelligence	London	CoE	RTO	https://www.turing.ac.uk/
Manufacture of a range of vessels within Aluminium	Boatbuilder/High Speed Craft Production	Aluminium Craft Centre of Excellence	Wight Shipyard Co/OCEA, Diverse Marine, Aluminium Marine Consultants British Marine - Leisure & Small Commercial	Manufacture	Aluminium craft construction 8-50m all co-located on the Isle of Wight	Isle of Wight	CoE	Industrial	
Clean Energy	Clean Energy/Low Emission Propulsion	Appledore Clean Maritime Innovation Centre	Torridge District Council (TBC)	Design	R&T, innovation in clean maritime technology and support industries	Appledore, Devon	CoE	RTO	Appledore Clean Maritime Innovation Centre | Torridge District Council
Design, Safety (maneuvering)	Design Specialist	Atkins	Atkins	All	Terminal designs, asset inspection and maintenance, navigation, berthing, mooring assessment		CoExp	Industrial	Atkins Maritime Engineering | Maritime Civil Engineers (atkins-maritime.com)
Autonomy	Autonomy	Autonomous Marine Systems (AMS) Research Group	University of Plymouth	Concept Design & Prototype Development	Expertise in artificial intelligence (AI), optimisation techniques, advanced control systems engineering theory, multi-sensor data fusion, marine vehicle dynamics, industrial dynamics, thermodynamics and fluids, smart materials, marine power plant, marine vehicles performance prediction, marine propulsion, integrated navigation systems and marine renewable energy	Plymouth	CoE	Academic	https://www.plymouth.ac.uk/research/autonomous-marine-systems#:~:text=The%20Autonomous%20Marine%20Systems%20(AMS,within%20the%20UK%20and%20globally.
Autonomy	Autonomy	Autonomous Marine Systems Research Centre	University of Plymouth	Support and conversion	Autonomous Marine Systems Research Centre	Plymouth	CoExp	Industrial	https://www.plymouth.ac.uk/student-life/your-studies/research-

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Design, Manufacture, Construction, Test and acceptance, In service support	End to End Lifecycle	Babcock Marine	Babcock International Group	All	Core skills include naval architecture, systems engineering, multi-discipline design support and project management for new build and in-service commercial and defence vessels. Programme management and Supply Chain Warship concept design Warship functional design Warship detail design Steel manufacture Pipe manufacture Ship assembly and outfit Ship commissioning and trials Warship in-service support, upgrade and refit Support engineering	Rosyth, Scotland / Bristol / Plymouth	CoExp	Industrial	Marine - Babcock International
Design, Manufacture, Construction, Test and acceptance, Combat Systems Integration	End to End Lifecycle	BAE Systems Naval Ships	BAE Systems plc	All	Encompasses ship design, build and combat systems capability for the surface fleet. Specialising in naval surface shipbuilding and combat systems integration and Machinery control systems. It is the largest shipbuilding company in the United Kingdom, one of the largest shipbuilders in Europe, and one of the world's largest builders of complex warships. Complex programme management and Supply Chain Warship concept design Warship functional design and systems integration Warship detail design Naval Combat Systems design and integration Steel manufacture Pipe manufacture Light fabrication and accomodation manufacture Ship assembly and outfit Ship commissioning and trials Warship in-service support, upgrade and refit Support engineering	Glasgow, Bristol, Portsmouth	CoExp	Industrial	https://www.baesystems.com/en/home
Detail Design	Design Specialist	Belcan	Belcan	Design	End-to-end engineering services from conceptual design to aftermarket support. Engineering services; Functional design; Detail design; Support engineering	East Kilbride, Scotland	CoExp	Industrial	Global Engineering Services & Innovative Solutions | Belcan
Concept and functional design	Design Specialist	BMT	BMT	Design	Can support every stage of the project lifecycle with a wide range of high-quality products and services, all backed by expertise across sectors, geographies and capabilities. Engineering consultancy; Concept design; Functional design; Support engineering; Technology development.	Teddington, Bath	CoExp	Industrial	https://www.bmt.org/how-we-work-with-you/maritime-design-consultancy/
Operational Safety		British Tug Owners Association	British Tug Owners Association	Operational, In Service	Tugboat operational safety - represents the interests of port towage operators from large corporates to smaller privately-owned companies in addition to a number of Port and Council Authorities		CoExp	Trade Association	https://britishtug.com/

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Welding, Manufacture, construction, support	Manufacturing	Cammell Laird	Cammell Laird	Manufacture, Construction, Support, Refit, Conversion	Cammell Laird has a long-standing and well-earned reputation for delivering highly complex steel fabrication projects across the UK and beyond. Commercial ship maintenance, repair, refit and conversion; Naval ship maintenance, repair and refit; Dry Docks (4); Steel manufacture; Ship assembly and outfit	Birkenhead	CoExp	Industrial	https://www.cammell-laird.co.uk/fabrication
Underwater Robotics	Autonomy	CeBotiX Centre at the NOC	National Oceanographic Centre	All	Mission to help the UK move forward faster and together, towards a future of smart shipping. Technology development, workforce training, and assurance against standards	Various - South Coast of England and in Scotland	CoE	RTO	UK's National Centre for Operational Excellence for Marine Robotics Launches (rovplanet.com)
Offshore wind	Clean Energy/Low Emission Propulsion	Celtic Sea Floating Offshore Wind Programme	Crown Estate / Offshore Renewable Energy Catapult	All	Offshore wing exploitation in Celtic Sea	Celtic Sea	CoE	HMG	Celtic Sea Floating Offshore Wind Programme (arcgis.com)
	Clean Energy/Low Emission Propulsion	Centre for Decarbonisation and Offshore Renewable Energy, Marine Station	University of Plymouth						
	Clean Energy/Low Emission Propulsion	Centre for Future Clean Mobility (CFCM)	University of Exeter			Exeter			
Safety (Manouvering - concept), Maritime Safety, de-Carbonisation, Efficiency and	Ship Theory	Centre for Maritime Futures	University of Southampton	Concept Design & Prototype Development	Sustainable programme of research in four key themes, Maritime Safety, de-Carbonisation, Efficiency and Digitalisation	Southampton	CoE	Academic	https://www.southampton.ac.uk/engineering/research/centres/centre-for-maritime-futures.page
Decarbonisation	Clean Energy/Low Emission Propulsion	Clean Maritime Research Hub (DfT/led by Durham University) - Recently announced during LISW	DfT / Durham University	All	The UK National Clean Maritime Research Hub (UK-MaRes Hub) aims to accelerate the decarbonisation and elimination of air pollution from maritime activity in ports and at sea. As well as environmental impacts, the Hub will also focus on the potential economic and social benefits of transitioning to a clean maritime future.	Durham	CoE	Academic	Home - UK National Clean Maritime Research Hub (durham.ac.uk)
		Connected Places Catapult							
Batteries (workboats), Batteries (Leisure Vessels)	Clean Energy/Low Emission Propulsion	CPI - Energy Storage	CPI-UK	Concept Design & Prototype Development		Teesside	CoE	RTO	https://www.uk-cpi.com/energy-storage/battery-materials
Digital Shipyard	Manufacturing	DAFNI – Digital Twinning programme	University of Sheffield	Manufacture, Construction		Sheffield	CoE	Academic	
Robotics, Renewables	Autonomy	DARE – The Digital, Autonomous and Robotics Engineering (DARE) Centre - OREC	OREC	All	Test demonstrate and commercialise innovative digital and robotic products and services for the offshore renewable energy market	Blythe	CoE	RTO	DARE Centre | digital and robotics facilities | ORE Catapult
Digital Technology	Manufacturing	Digital Catapult	Digital Catapult	All	Accelerate digital technology adoption to benefit the UK	London	CoE	RTO	Digital Catapult - The UK authority on advanced digital technology | Digital
Underwater accoustics	Ship Theory	DIRDI - Durham Institute of Research, Development, and Invention (DIRDI) (includes within it the Centre for Underwater Acoustic Analysis (CUAA))	Established by Coltraco Ltd in partnership with Durham University	All	A scientific research institute. DIRDI is focused on commercialisation of scientific outputs. Centre for Underwater Acoustic Analysis (CUAA) conducts research on the behaviour of sound underwater, as well as the informational techniques by which received acoustic signals are processed, in order to inform the development and optimisation of novel submarine acoustic technologies	ORBIT NETPark, Durham	CoE	Academic	Centre for Underwater Acoustic Analysis – DIRDI
Power Systems	Power & Propulsion	Driving the Electric Revolution - Industrial Centres (DER-IC)	Various	Design	provide a UK network of open access facilities, growing world class design, manufacturing, test and validation capabilities; and work with industrial partners to develop UK supply chains, accelerating delivery of PEMD solutions to global markets	Various	CoE		https://www.der-ic.org.uk/

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Welding	Manufacturing	EAPL	EAP Ltd	Manufacture	Marine Fabrication: Vessel steel repairs to decks or vessel modifications; Pontoon and Pier repair or manufacture; Dredging Plough design and manufacture; Offshore repairs on vessels or jack leg barges; Ongoing R&M on Marine Equipment	Chatham	CoExp	Industrial	EAP Ltd | Support Services to the Marine and Industrial Sectors (eap-ltd.co.uk)
Low carbon propulsion	Power & Propulsion	Ecomar Propulsion	Ecomar	Concept Design, Prototype Development, Manufacture	Research, development and production of high performance electric and hybrid hydrogen marine propulsion systems	Fareham	CoE	Industrial	Home of Electric Marine Propulsion | Ecomar Propulsion Ltd
Wave and tidal energy	Clean Energy/Low Emission Propulsion	EMEC – European Marine Energy Centre	EMEC – European Marine Energy Centre	All	demonstrating and testing wave and tidal energy converters	Stornaway, Orkney	CoE	RTO	EMEC: European Marine Energy Centre
Batteries (workboats), Batteries (Leisure Vessels)	Clean Energy/Low Emission Propulsion	Energy Innovation Centre - WMG	University of Warwick - WMG	Concept Design & Prototype Development	national facility for battery research across the R&D process from materials and electrochemistry through to application integration and recycling / re-use	Coventry	CoE	Academic	https://warwick.ac.uk/fac/sci/wmg/about/facilities/energyinnovationcentre/
Clean Energy	Clean Energy/Low Emission Propulsion	Energy Systems (ES) Catapult - Renewables	Energy Systems Catapult	Concept Design & Prototype Development	Infrastructure and Engineering team offering specialist knowledge and practical experience in technology development and deployment, considering the technological, engineering, economic, regulatory and policy implications for innovations and investment decisions.	Birmingham	CoE	Academic	https://es.catapult.org.uk/what-we-do/future-energy-system/clean-tech-engineering/renewables/
Renewable energy	Clean Energy/Low Emission Propulsion	Energy Transition Zone (ETZ)		All	Integrated energy cluster	Aberdeen	CoE	RTO	https://etzltd.com/
Organisational best practice	Shipyard Efficiency	First Marine International - Royal Haskoning DHV	Royal Haskoning DHV	Construction	Shipyard efficiency advice, planning, engineering and procuring successful shipyards across the globe and offer a unique and comprehensive service to our clients that has made us world leaders in the maritime sector			Industrial	Shipyards commercial | Royal HaskoningDHV
HydroDynamics	Ship Theory	Fluid Mechanics UCL	University College London	Design	investigates the hydrodynamics, turbulence and transport processes in fluvial, coastal and offshore waters, as well as airflows in the built environment	London	CoE	Academic	https://www.ucl.ac.uk/civil-environmental-geomatic-engineering/research/groups-centres-
Oceanography	Marine Science	Future Marine Research Infrastructure – Includes the Net Zero Oceanographic Capability	SMI - Marine Science & Technology	All	Enables environmental science at a time when our ability to observe the ocean in ever greater detail is imperative if we are to chart a sustainable future on this planet			RTO	Future Marine Research Infrastructure | Leading the way with Net Zero Oceanographic Capability (fmri.ac.uk)
Gears	Power & Propulsion	Gear Technology Design Unit - Research Group	University of Newcastle	Design, Manufacture	Gear Technology Design Unit: a specialist centre with expertise in Mechanical Power Transmission Systems. We have been delivering innovative design, development and research consultancy services since 1970.	Newcastle	CoE	Academic	https://www.ncl.ac.uk/engineering/research/marine-offshore-engineering/marine-hydrodynamics-structures/
Underwater industries	Autonomy	Global Underwater Hub		All	Global Underwater Hub is the leading trade and industry development body for the UK's underwater sector	Aberdeen, Bristol, Newcastle	CoExp	Trade Association	Home - Global Underwater Hub

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Manufacture, construction, support	Manufacturing	Harland and Wolff	Harland & Wolff	Manufacture, construction, support	Large dry docks (Belfast); Commercial and Naval ship support, maintenance, refit; Steel manufacture; Heavy fabrication (ships, offshore structures); Ship assembly. With direct deep water access and 1,800m of quayside space, H&W Belfast shipyard welcomes a wide variety of vessels and structures. The site boasts a vast main drydock and two 140m 'Goliath' gantry cranes. Within the 30,000m2 covered fabrication halls, up to 100-250 tonnes of structural steel can be handled per week.	Belfast (NI)/Appledore (England)/Methel (Fife)/Arnish(Stornoway)	CoExp	Industrial	https://www.harland-wolff.com/fabrication-construction/
Repair, Conversion, support	Manufacturing	Harland and Wolff - Cruise and Ferry	Harland & Wolff	Refit	Two of Europe's largest dry docks capable of handling some of the largest cruise ships.	Belfast (NI)	CoExp	Industrial	Cruise & Ferry - Harland & Wolff (harland-wolff.com)
	Manufacturing	High Value Manufacturing Catapult (HVMC)	HVM (High Value Manufacturing) Catapult	Manufacturing	HVM Catapult is a strategic research and innovation hub for industry, supporting the UK's national manufacturing priorities.	Birmingham	CoE	RTO	High Value Manufacturing Catapult - HVMC
Detail Design	Design Specialist	Houlder	Houlder	Design	Range of advisory, design, engineering, analysis and project implementation services		CoExp	Industrial	https://www.houlderltd.com/sector/commercial-shipping
Detail Design	Design Specialist	ICE Marine Design	ICE Marine Design	Design	services range from vessel concept design through to basic (Class approved functional design) and detail design to the development of production information for shipyards; covering all core naval architecture and marine engineering disciplines such as hydrodynamics, structural, mechanical, piping, electrical, instrumentation, outfit and HVAC.	London	CoExp	Industrial	ICE: Europe's largest independent ship design group (icedesign.info)
Innovation		Imperial College London Innovation Hub	Imperial College	All	Innovation and research translation	London	CoE	Academic	I-HUB | Research and Innovation |
	Marine Science	Institute of Aquaculture	University of Stirling						
Composites, sustainable materials	Manufacturing Materials	Lightweight Manufacturing Centre	NMIS Group, University of Strathclyde	Concept Design & Prototype Development, Manufacture	Composites design, manufacture and re-use. The Lightweight Manufacturing Centre (LMC) is a specialist technology centre within the National Manufacturing Institute Scotland. Focused on exploring the next generation of sustainable materials, products and processes for a net-zero world. Examples include helping lighter-weight battery enclosures for electric vehicles, composite panels for aircraft wings as well as tackling heavyweight industry challenges, such as recycling wind turbines and materials like glass fibre.	Glasgow	CoE	Academic	
Port Infrastructure		Liverpool John Moores University	Liverpool John Moore's University	All	ports, berthing, civil engineering, accident investigations	Liverpool	CoE	Academic	LJMU Maritime Centre | Liverpool John Moores University
Test & Acceptance	Test & Acceptance	Lloyds Register	Lloyds Register	All	Seaworthiness, assurance, Insurance, etc	London	CoExp	Industrial	Lloyd's Register – classification, training and advisory services (lr.org)

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Boat Builder	Boatbuilder/High Speed Craft Production	Mainstay Marine Solutions	Mainstay Marine Solutions	Manufacture/ Refit	Workboat Design and Build, Marine Energy Devices, Engineering and Marine Services	Wales SA72 6TE	CoExp	Industrial	
Welding, Manufacture, heavy transportation	Manufacturing	Malin	Malin Group	Manufacture	Steel manufacture; Heavy fabrication; Towage and heavy transportation. Facilities include: A large undercover area of 200,000m2 supported by craneage in the form of both 500 tonnes and 100 tonne gantry cranes with an under hook height of 23m, two 50Te and one 10Te overhead Plant and machinery from pipe work formers and notching machines, to plasma profiling and drilling machines. Exotic material welding services plus mig, tig and stick welding depending on your specific requirements. Non Destructive Testing (NDT) capabilities, with ultrasonic testing, magnetic particle testing, liquid penitrant inspection and qualified CSWIP 3.1 welding inspection.	Glasgow	CoExp	Industrial	Our Fabrication Facility – Malin Group
Digital shipyard, Machining, Process Mapping	Manufacturing	Manufacturing Technology Centre (MTC)	High Value Manufacturing Catapult	Manufacture, Construction	Provide expertise across all aspects of manufacturing, with particular focus on manufacturing processes, assembly processes, and the use of data	Coventry	CoE	RTO	MTC | Home | Transforming Industry for a Sustainable World (the-mtc.org)
Industrial - academic engagement		Marine Business Technology Centre (advanced marine autonomy, alternative propulsion, environmental monitoring, advanced materials and cyber security. Includes the Smart Sound Plymouth)	University of Plymouth	Research, testing, proving, production	The Marine Business Technology Centre (MBTC) is the gateway for accessing comprehensive research and development support as well as cutting-edge facilities and expertise.	Devonport		Academic	https://www.marinebusinesstechnologycentre.co.uk/
HydroDynamics	Ship Theory	Marine computational fluid dynamics group	University of Southampton	Design	focused on fluid behaviour in the maritime environment and in particular the interface between the interpretation of analysis (be it experimental, numerical or theoretical) and maritime design	Southampton	CoE	Academic	https://www.southampton.ac.uk/engineering/research/groups/fsi/marine_computational_fluid_dynamics.page
Clean Energy	Clean Energy/Low Emission Propulsion	Marine Energy	University of Exeter	Concept Design & Prototype Development	focuses on offshore renewable energy engineering as well as social dimensions of marine energy	Exeter	CoE	Academic	https://www.exeter.ac.uk/research/eteerenergy/researchthemes/marineenergy/
Renewable energy	Clean Energy/Low Emission Propulsion	Marine Energy Engineering Centre of Excellence (MEECE) - Delivered by: ORE Catapult	OREC (Offshore Renewable Energy Catapult)	All	Commercialisation of the wave, tidal and offshore wind sectors by reducing cost of energy.	Pembroke	CoE	RTO	https://ore.catapult.org.uk/what-we-do/innovation/marine-energy/meece/
Offshore Renewable Energy Catapult	Clean Energy/Low Emission Propulsion	Marine Energy Engineering Centre of Excellence (MEECE) - Marine Energy Test Area (META) - Delivered by: Marine Energy Wales							
Offshore Renewable Energy Catapult	Clean Energy/Low Emission Propulsion	Marine Energy Engineering Centre of Excellence (MEECE) - Pembroke Dock Marine Celtic Sea Cluster							
Offshore Renewable Energy Catapult	Clean Energy/Low Emission Propulsion	Marine Energy Engineering Centre of Excellence (MEECE) - Pembroke Port developments - Delivered by: Port of Milford Haven							
Offshore Renewable Energy Catapult	Clean Energy/Low Emission Propulsion	Marine Energy Engineering Centre of Excellence (MEECE) - Pembrokeshire Demonstration Zone (PDZ) - Delivered by: Celtic Sea Power							

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Autonomy	Autonomy	Marine Engineering and Autonomy (MSc) - Civil and Maritime Engineering	University of Southampton	Concept Design & Prototype Development	Masters programme covering advanced understanding of the fundamental principles, methods and applications of maritime engineering science.	Southampton	CoE	Academic	https://www.southampton.ac.uk/courses/maritime-engineering-science-marine-engineering-autonomy-masters-
HydroDynamics	Ship Theory	Marine Hydrodynamics & Structures - Research Group	University of Newcastle	Design, Manufacture	Marine Hydrodynamics and Structures: deep knowledge of marine coatings and fouling. We have unparalleled expertise in vessels performance at sea. We develop novel and innovative hydrodynamic devices.	Newcastle	CoE	Academic	
Power, Energy, Propulsion	Power & Propulsion	Marine Power Test Facility (Whetstone)	GE	All	Facility used for test and emulation of integrated electric ship power, energy and propulsion systems. Emulating **full load/scale** systems. **Collaborative** facility (third party open access subject to availability), used extensively for multi-party test and de-risking of integrated systems ahead of sea trials, or standalone equipment. Used for **UK and international** programmes (e.g. US Navy, FR Navy), surface and subsea. Across innovation, project, training and update phases. Naval and commercial marine focus; available for land-based systems	Whetstone, Leicestershire	CoE	Industrial	gepowerconversion.com
Clean Energy, Climate change, energy security	Clean Energy/Low Emission Propulsion	Marine Resources & Renewable Energy - Research Group	University of Newcastle	Concept Design & Prototype Development	Climate change, energy security and future mobility and trade	Newcastle	CoE	Academic	https://www.ncl.ac.uk/engineering/research/marine-offshore-engineering/marine-resources-
Underwater Robotics	Autonomy	Marine Robotics Innovation Center - recently established at National Oceanography Centre (NOC)	National Oceanographic Centre (NOC)	All	developing and deploying MAS and other equipment in the most challenging of ocean environments	Southampton	CoE	RTO	https://noc-innovations.com/innovation-centre/
Autonomy	Autonomy	Maritime Autonomy Research Centre	Solent Univeristy	Concept Design & Prototype Development	A pioneering new research centre exploring maritime autonomy was launched by Warsash Maritime School, part of Solent University, Southampton	Southampton	CoE	Academic	https://www.solent.ac.uk/news/launch-of-new-uk-maritime-autonomy-research-centre
Maritime Futures	Clean Energy/Low Emission Propulsion	Maritime Futures	University of Southampton	Design	Shell Shipping and Maritime have supported research at the University into improving the efficiency of shipping for more than a decade. In 2014 they enabled the creation of a Chair in Ship Safety and Efficiency and the Centre for Maritime Futures was launched in September 2019	Southampton	CoE	Academic	https://www.southampton.ac.uk/engineering/research/centres/centre-for-maritime-futures.page
	Ship Theory	Maritime Platform Signatures	QinetiQ	Concept Design & Prototype Development, Design, Manufacture, Construction,	Analysis and optimisation of platform signatures including acoustic, magnetic, electro-magnetic..	Winfrith Technology Park (Dorset)	CoE	Industrial	
	Design Specialist	Maritime Strategic Capabilities Centre	QinetiQ	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Accepatance, In-service Support including training and mission rehersal, Disposal.	At its Haslar site, QinetiQ delivers bespoke solutions that deliver novel, unique and exceptional outcomes in all areas of ship & submarine design, hydrodynamic testing and technical consultancy. In platform Design and Life Support (PDLS) Qinetic are shaping the future of ships and submarines by delivering outstanding maritime services globally. They enable its clients to operate to the highest standards, safely and efficiently by delivering exceptional technical solutions.	Haslar (Gosport), Chichester & Rosyth.	CoE	RTO	https://www.qinetiq.com/en/what-we-do/services-and-products/qinetiq-maritime-consultancy
	Manufacturing	Maritime Strategic Capabilities Centre	QinetiQ	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Accepatance, In-service Support including training and mission rehersal, Disposal.	Platform design, safety and signatures including: seakeeping manoeuvring & control; resistance and propulsion; propeller and propulsor design; marine structures including materials, welding and NDE, survivability, shock testing; life support including atmospheres, submarine escape and rescue; diving and hyperbaric medicine; signatures including hydrostatics and stealth materials. Computational and physical modelling.	Haslar (Gosport), Chichester & Rosyth.	CoE	RTO	
	Power & Propulsion	Maritime Strategic Capabilities Centre	QinetiQ			Haslar (Gosport), Chichester & Rosyth.	CoE	RTO	
	Ship Theory	Maritime Strategic Capabilities Centre	QinetiQ			Haslar (Gosport), Chichester & Rosyth.	CoE	RTO	
	Test & Acceptance	Maritime Strategic Capabilities Centre	QinetiQ			Haslar (Gosport), Chichester & Rosyth.	CoE	RTO	

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Maritme Cyber Security	Autonomy	Maritme Cyber Security	University of Plymouth	Support and conversion	Maritme Cyber Security	Plymouth	CoExp	Industrial	https://www.plymouth.ac.uk/student-life/your-studies/research-degrees/research-areas/maritime-studies
Innovation		MarRI-UK	University of Strathclyde	All	Accelerating the delivery of world-leading research and innovation for the UK maritime sector through collaboration	Glasgow		Academic	https://marri-uk.org/
Electromagnetic, magnetic and acoustics signature measurement and analysis. Above and underwater weapons.	Test & Acceptance	MOD T3E (Test, Trials, Training and Evaluation)	QinetiQ	Concept testing & evaluation, Platforms Test & Acceptance, In-service Support including training and mission rehearsal.	Electromagnetic, magnetic and acoustics signature measurement and analysis. Static and underway. Above and underwater weapons.. At sea, T3E provides a wide range of Test & Evaluation (T&E) services, drawing on technical expertise and wide experience of managing ship and submarine trials. Above water stealth and counter-measure assessment: We offer both static and dynamic radar cross section services and support measurement, analysis and reporting on characteristics of surface vessels, submarines, aircraft and chaff.	Plymouth, Portland , Weymouth, Clyde (Barons Point), Loch Goil, Loch Fyne, Raasay Sound.	CoE	RTO	T3E (Test, Trials, Training and Evaluation)
Composites	Manufacturing Materials	National Composites Centre (NCC)	National Composites Centre	Manufacture	Advanced composites design and development, digital manufacturing and sustainable engineering expertise all accessed in one place.	Bristol	CoE	RTO	NCC | Composites and Engineering | National Composites Centre (nccuk.com)
Shock testing	Test & Acceptance	National Engineering Laboratry (NEL)	TÜV NEL	Test and Acceptance	Shock and vibration testing ensures product performance under extreme conditions. Vibration testing and shock testing are used to simulate in a controlled laboratory environment the extreme conditions that a product may face during use, such as mishandling, dropping, and various modes of shipmen	East Kilbride, Scotland	CoE	Industrial	Shock and Vibration Testing - Ensure Product Performance | TÜV SÜD (tuvsud.com)
Digital shipyard	Manufacturing	National Manufacturing Institute Scotland (NMIS)	University of Strathclyde	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Accepatance	A multidisciplinary team of experts work with companies to help them embrace the use of digital technologies. NMIS offers solutions to help overcome roadblocks and inefficiencies, increase productivity, improve sustainability and push forward innovation within the manufacturing and engineering community.	Glasgow	CoE	Academic	Home | National Manufacturing Institute Scotland (NMIS)
Maritime Mission System Concepts, Design, Integration, Assurance, Training & Mission Rehersal. Includes Sensors, Command & Control, Communication Systems, Uncrewed and Autonomous Systems.	Maritime Missions Systems	National Maritime Systems Centre (Portsdown Technology Park)	QinetiQ	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Acceptance, In-service Support including training and mission rehersal.	Integration Facility including companies from e.g. BAE Systems, Thales, Rolls Royce + MarRI-UK. At PTP, QinetiQ works closely with BAES and other OEM's to offer a comprehensive range of solutions and supporting services including the naval communications, information and combat systems design, procurement, installation and integration of a combat system. QinetiQ is fully independent and works with its multi domain customers to define needs, turn those needs into a manufacturer's specification, build prototypes and run demonstrations, if necessary, to identify and	Portsdown Technology Park	CoE	RTO	https://www.qinetiq.com/en/what-we-do/services-and-products/naval-mission-systems
Oceanography	Autonomy	National Oceanography Centre (NOC) – MARS	National Oceanographic Centre	All	Deploying autonomous vehicles and robots into harsh, subsea environments		CoE	RTO	https://noc.ac.uk/technology/technology-development/marine-autonomous-robotic-systems
Autonomy	Autonomy	National Physical Laboratory (NPL) - Assured Autonomy	National Physical Laboratory (NPL)	Concept Design & Prototype Development	Assured Autonomy: addressing the challenge of how to assure the reliability and safety of autonomous systems	Teddington	CoE	RTO	https://www.npl.co.uk/national-challenges/security/assuring-autonomous-systems
NDE / NDT NDE / NDT Weld Testing	Test & Acceptance	National Physical Laboratory (NPL) - NDT (NonDestructive Testing) Labs	National Physical Laboratory	Test and Acceptance	NDT (Non-Destructive Testing) Labs: NDT provides a means of identifying damage and irregularities in materials and is often the only means of obtaining information about the current 'health' of a structure. It can be used to detect and size in-service and manufacturing defects. NDT is used for on-line production quality control through to in-service inspection, structural health monitoring (SHM) and life management. NPL has extensive NDT and surface analysis instrumentation and expertise able to support industry in materials characterisation, product development, and long-term performance assessment and damage monitoring. NPL aims to promote the advancement of metrology underpinning non-destructive testing, condition monitoring and diagnostic engineering (including structural health monitoring) for design and quality assurance purposes.	Teddington	CoE	RTO	https://www.npl.co.uk/products-services/advanced-materials/non-destructive-testing
Autonomy and Automation	Autonomy	National Robotariam	Heriot-Watt University	All	World leading centre for Robotics and Artificial Intelligence	Edinburgh	CoE	RTO	https://www.hw.ac.uk/uk/research/th

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Manufacture of a range of vessels within Aluminium	Boatbuilder/High Speed Craft Production	Ocea UK	Ocea		Design & construction of aluminium vessels	Isle of Wight	CoExp	Industrial	https://oceauk.com/
Offshore renewables	Clean Energy/Low Emission Propulsion	Offshore Renewables	University of Plymouth	Support and conversion	Offshore renewables	Plymouth	CoExp	Industrial	https://www.plymouth.ac.uk/student-life/your-studies/research-
Floating offshore wind	Clean Energy/Low Emission Propulsion	OREC - Floating Offshore Wind Centre of Excellence (FOW CoE)	OREC	All	reduce the cost of energy from floating wind		CoE	RTO	https://ore.catapult.org.uk/what-we-do/innovation/fowcoe/
Vessel provider. An offshore service provider, clean marine	Clean Energy/Low Emission Propulsion	OS Energy	NOF	Operational, In Service	Specialist Multi Purpose Offshore Vessel Provider for Environmental, Geological, UXO Surveys and ROV Inspections	Newcastle	CoExp	Industrial	https://www.nof.co.uk/supply-chain-directory/os-energy-uk-ltd/
Autonomy	Autonomy	OXA Oxford University – Formerly Oxbotica (road)	Formerly Oxford University	Concept	Autonomy (land based)		CoExp	Industrial	https://oxa.tech/about/#investors
Infrastructure	Ports & Terminals Infrastructure?	PIANC (Regulations for Ports & Terminals)		All	Regulations for Ports & Terminals) - world association for Waterborne Transport Infrastructure		CoE	RTO	https://www.pianc.org/
Green Power	Clean Energy/Low Emission Propulsion	Port of Tyne Centre (Offshore Renewables)	Port of Tyne	Design	Offering sites and berths to accommodate deep drafted vessels with no beam restriction, Port and Tyne Clean Energy Park users will benefit from unrestricted, lock free access to berths with 13.0m of depth alongside. The Port is a safe haven for offshore wind operators and other renewables specialists that is open 24/7, 365 days a year, during all tide states, the statement said.	Newcastle	CoE	Industrial	Port of Tyne launches Tyne clean energy park - Port Technology International
Power Systems	Power & Propulsion	Power Networks Demonstration Centre (PNDC)	University of Glasgow	Design, Concept Design & Prototype Development	PNDC delivers accelerated technology and system validation using its flexible real-world demonstration environment to support integrated whole energy systems validation capability, incorporating Net Zero mobility, heat, hydrogen and the electrification of transport	Glasgow	CoE	Academic	https://www.strath.ac.uk/research/pndc/
Safety (Manouvering - concept)	Ship Theory	Power Networks Demonstration Centre (PNDC)	University of Glasgow	Design, Concept Design & Prototype Development	PNDC delivers accelerated technology and system validation using its flexible real-world demonstration environment to support integrated whole energy systems validation capability, incorporating Net Zero mobility, heat, hydrogen and the electrification of transport	Glasgow	CoE	Academic	
Clean Energy Fuels	Clean Energy/Low Emission Propulsion	Powertrain Research Centre	University of Nottingham	Concept Design & Prototype Development	Green ammonia, Hydrogen	Nottingham	CoE	Academic	https://www.nottingham.ac.uk/research/groups/powertrain-research-centre/index.aspx
Production build of composite hulled leisure craft	Boatbuilder/High Speed Craft Production	Production Build Leisure Craft	Princess Yachts, Sunseeker, Fairline, Oyster	Design, Manufacture	UK has two of the three top global brands producing c. 600+ boats a year in this market segment.	South West, East Midlands	CoExp	Industrial	

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Propulsion	Power & Propulsion	Rolls-Royce	Rolls-Royce Group plc	Through-life integration	Marine propulsion systems from gas turbines through diesel and zero carbon solutions including fuel cells and alternative fuels.	London	CoExp	Industrial	Marine | Rolls-Royce
Ship Safety and Efficiency	Ship Theory	Ship Safety and Efficiency	University of Southampton	Design	Shell Shipping and Maritime have supported research at the University into improving the efficiency of shipping for more than a decade. In 2014 they enabled the creation of a Chair in Ship Safety and Efficiency and the Centre for Maritime Futures was launched in September 2019	Southampton	CoE	Academic	https://www.southampton.ac.uk/engineering/research/centres/centre-for-maritime-futures.page
Design, Test and acceptance	Autonomy	Smart Sound Plymouth – National Centre for Coastal Autonomy (NCCA)	Marine Business Technology Centre Plymouth University	All	Aimed at delivering world-leading capability in coastal autonomy. Proving area for designing, testing and developing cutting edge products and services for the marine sector. This multi-million pound development provides access to first class off- and onshore facilities plus award-winning marine science and technology expertise. At its core, the NCCA comprises a fleet of state-of-the-art surface autonomous vessels, sub-surface coastal platforms and sophisticated scientific buoys integrated on a unique high-speed marine communications network	Plymouth	CoE	RTO	https://www.marineresearchplymouth.ac.uk/coastal-autonomy Home - Smart Sound Plymouth
Superyacht Design, Manufacture, Maintenance & Refit	Boatbuilder/High Speed Craft Production	Superyacht Manufacture, Maintenance & Refit	Pendennis / Princess Yachts/Sunseeker	Manufacture/ Refit	With a history stretching over 35 years, Pendennis Shipyard is one of the world's leading superyacht refit and custom build facilities renowned for its diverse sailing and motor yacht projects. Based in its 14 acre waterfront location in the thriving maritime town of Falmouth, Pendennis employs over 450 highly skilled tradespeople and has seen its people ethos rewarded with over 20 awards since its foundation.	Falmouth/Plymouth/ Poole	CoExp	Industrial	
Autonomy	Autonomy	The Autonomous Marine Systems (AMS) Research Group	University of Plymouth	Concept Design & Prototype Development	Expertise in artificial intelligence (AI), optimisation techniques, advanced control systems engineering theory, multi-sensor data fusion, marine vehicle dynamics, industrial dynamics, thermodynamics and fluids, smart materials, marine power plant, marine vehicles performance prediction,	University of Plymouth	CoE	Academic	https://www.plymouth.ac.uk/research/autonomous-marine-systems#:~:text=The%20Autonomous%20Marine%20Systems%20(AMS,within
Manufacture of a range of vessels within Aluminium	Boatbuilder/High Speed Craft Production	The Isle of Wight Aluminium Shipbuilding COE					CoE		
	Clean Energy/Low Emission Propulsion	The Power Networks Demonstration Centre - (PNDC)	University of Strathclyde	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Accepatance	A whole energy systems research, test and demonstration facility with a focus on the de-risking and acceleration of novel electricity, heat and transport systems to controbute to net zer emissions. PNDC delivers accelerated technology and system validation using its flexible real-world demonstration environment to support integrated whole energy systems validation capability, incorporating Net Zero mobility, heat, hydrogen and the electrification of transpor	Glasgow	CoE	Academic	
	Clean Energy/Low Emission Propulsion	The Renewables Wave and Tidal Centre (Pembroke Docks)							
	Clean Energy/Low Emission Propulsion	Transport Systems Catapult (now Connected Places Catapult) - Green Corridors etc							

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
Equipment testing	Test & Acceptance	TUV NEL - MARINE PRODUCT TESTING AND CERTIFICATION SERVICES	TÜV NEL	Test and Acceptance	TÜV SÜD has been active in marine products testing for more than 20 years, with our global network supporting customers with their test and certification requirements.	East Kilbride, Scotland	CoE	Industrial	Marine | TÜV SÜD (tuvsud.com)
Welding	Manufacturing	TWI (formerly The Welding Institute)	TWI	Manufacture	TWI provides engineering consultancy to its Members and stakeholders with authoritative and impartial expert advice, knowhow and safety assurance related to engineering, materials and joining technologies.	Cambridge	CoE	RTO	Joining Innovation with Expertise - TWI (twi-global.com)
Clean Energy	Clean Energy/Low Emission Propulsion	UCL ENERGY INSTITUTE	UCL	Concept Design & Prototype Development	shipping research activity is centred on understanding patterns of energy demand in shipping and how this knowledge can be applied to help shipping transition to a low carbon future. Investigates the hydrodynamics, turbulence and transport processes in fluvial, coastal and offshore waters, as well as airflows in the built environment	London	CoE	Academic	https://www.ucl.ac.uk/bartlett/energy/research/energy-and-transport/shipping
Detail Design	Design Specialist	UCL Warship Design Courses	University College London	Design	Naval Architecture MSc is designed to provide students with knowledge and skills in naval architecture theory, analysis and design procedures for both naval and merchant ships.	London	CoE	Academic	https://www.ucl.ac.uk/prospective-students/graduate/taught-degrees/naval-architecture-msc
Autonomy	Autonomy	University of Strathclyde (incorporating Ocean Air & Space, NAOME, Kelvin Hydrodynamics Laboratory, SEARCH Lab)	University of Strathclyde	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Accepatance	hydrodynamic study of bio-inspired robotic fish swimming, stability and manoeuvrability analysis of AUVs, robotic fish swimming in schooling modelling, rigid/flexible fins driven fish propulsion fluid mechanism and wake studies	Glasgow	CoE	Academic	https://www.strath.ac.uk/workwithus/oceanairspace/areasofexpertise/roboticsautonomy/
Clean Energy	Clean Energy/Low Emission Propulsion	University of Strathclyde (incorporating Ocean Air & Space, NAOME, Kelvin Hydrodynamics Laboratory, SEARCH Lab)	University of Strathclyde	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Accepatance	Ranked 1st in the UK & 4th in the world for Marine/Ocean Engineering. Green Hydrogen, Zero carbon fuels	Glasgow	CoE	Academic	https://www.strath.ac.uk/workwithus/oceanairspace/areasofexpertise/roboticsautonomy/
Digital shipyard	Manufacturing	University of Strathclyde (incorporating Ocean Air & Space, NAOME, Kelvin Hydrodynamics Laboratory, SEARCH Lab)	University of Strathclyde	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Accepatance	Development of novel robotic solutions to solve real problems in industry. Working with aerospace, energy, nuclear and oil and gas sectors, our research spans manufacturing robotics and fixed asset inspection. aim is to provide engineers with the latest tools for product quality assurance through the integration of traditional NDE technologies with the latest advances in automation, data processing and complex data set visualisation.	Glasgow	CoE	Academic	https://www.strath.ac.uk/workwithus/oceanairspace/areasofexpertise/roboticsautonomy/

CoE Topic	CoE Specialism	Name	Host Organisation	Lifecycle Stage	Expertise	Location	Centre of Excellence / Expertise	Type	URL
HydroDynamics	Ship Theory	University of Strathclyde (incorporating Ocean Air & Space, NAOME, Kelvin Hydrodynamics Laboratory, SEARCH Lab)	University of Strathclyde	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Acceptance	Determine the survivability of damaged ships, fluid structure-interaction for slender structures, sporting fluid dynamics and marine renewable energy	Glasgow	CoE	Academic	https://www.strath.ac.uk/workwithus/oceanairspace/areasofexpertise/roboticsautonomy/
Safety (Design)	Ship Theory	University of Strathclyde (incorporating Ocean Air & Space, NAOME, Kelvin Hydrodynamics Laboratory, SEARCH Lab)	University of Strathclyde	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Acceptance	Determine the survivability of damaged ships, fluid structure-interaction for slender structures, sporting fluid dynamics and marine renewable energy	Glasgow	CoE	Academic	https://www.strath.ac.uk/workwithus/oceanairspace/areasofexpertise/roboticsautonomy/
Process Mapping	Shipyard Efficiency	University of Strathclyde (incorporating Ocean Air & Space, NAOME, Kelvin Hydrodynamics Laboratory, SEARCH Lab)	University of Strathclyde	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Accepatance	Our operations research is focused on supporting the development and sustained performance of engineering businesses through the optimisation of its operations processes across the entire value chain. We look at: product concept and design through manufacturing; logistics; supply chain; remanufacturing and encompassing strategy; business models; change management; leadership; knowledge and information management; skills development	Glasgow	CoE	Academic	https://www.strath.ac.uk/workwithus/oceanairspace/areasofexpertise/roboticsautonomy/
NDE / NDT NDE / NDT Weld Testing	Test & Acceptance	University of Strathclyde (incorporating Ocean Air & Space, NAOME, Kelvin Hydrodynamics Laboratory, SEARCH Lab)	University of Strathclyde	Concept Design & Prototype Development, Design, Manufacture, Construction, Test & Accepatance	Determine the survivability of damaged ships, fluid structure-interaction for slender structures, sporting fluid dynamics and marine renewable energy. Development of novel robotic solutions to solve real problems in industry. Working with aerospace, energy, nuclear and oil and gas sectors, our research spans manufacturing robotics and fixed asset inspection. aim is to provide engineers with the latest tools for product quality assurance through the integration of traditional NDE technologies with the latest advances in automation, data processing and complex data set visualisation.	Glasgow	CoE	Academic	https://www.strath.ac.uk/workwithus/oceanairspace/areasofexpertise/roboticsautonomy/
Manufacture of a range of vessels within Aluminium	Boatbuilder/High Speed Craft Production	Wight Shipyard Co (Aluminum Shipbuilding CoE)	Wight Shipyard	Design, Manufacture, Construction	Design, Manufacturing, Construction of high speed craft and aluminium ship builder	Cowes, Isle of Wight	CoExp	Industrial	https://www.wightshipyard.com/

ANNEX 4 – Recommendation Summary – UK Transition to Net Zero

NSbS Centres of Excellence Gap Analysis – Summary Recommendation

THEME: Decarbonisation – UK Transition to Net Zero

1 Executive Summary

The focus of this paper is on Decarbonisation – Transition to Net Zero for the Shipbuilding Enterprise.

HMG's policy for marine decarbonisation, as outlined in the Clean Maritime Plan and its forthcoming refresh, sets a clear, ambitious, goal of net zero greenhouse gas (GHG) emissions from the domestic maritime sector by 2050, with the objective of reducing the sector's lifecycle emissions close to zero.

In order to drive this change, government uses a number of policy levers including incentives such as the Emissions Trading Scheme (ETS), legislation (through the climate change act) and funding such as through UK SHORE. Government policy to date can be characterised as largely setting ambition and encouraging R&D at the lower end of the TRL scale. It has so far left big decisions around technology choices to the market, and interventions to solve financial deltas in the capital and operational expenditure of decarbonising vessels has been limited.

Reaching Net-Zero shipping emissions by 2050 will require not just strong policy commitments but a revolution in maritime green technologies, be it fuels, machinery, electrical systems, propulsion or hull forms; and these have to be applied across all markets and sectors, both afloat and the shore infrastructure. There is a need to support retrofit of platforms and facilities, as well as new build.

The sector is already on the journey. It is estimated that Zero-emission Cruise Ships, Ferries, and Cargo Ships will set sail in UK waters within 2 years, creating thousands of new jobs, thanks to a £77m government investment in Clean Maritime Technology.

Industry led reports such as Mærsk Mc-Kinney Møller Centre for Zero Carbon Maritime Decarbonisation Strategy details progress of the transition in the shipping sector so far and outlines the actions that industry must take to move closer to the Paris 1.5degrees C trajectory. This is backed up by Marine Capital Ltd, with the support of UMAS and LR, UK Domestic Shipping: Mobilising Investment in Net Zero which identifies funding mechanisms that can be applied immediately to unlock untapped investment capital to finance the UK's domestic maritime sector to transition to net zero.

There is a consensus across industry of the importance of strategically addressing the challenge. Further to the reports cited, the industry workshops have been unanimous in calling for coherence in the national approach.

The CoE Recommendations for Decarbonisation – UK Maritime Transition to Net Zero is to focus on 2 key areas:

1 **Shipbuilding Enterprise Net Zero Overarching Body**. Create an empowered overarching body to co-ordinate the national journey to Maritime Net Zero. It is noted that the Clean Maritime Council are ideally placed to assume this role.

2 **Green Technology 'Federation'.** Acknowledging the various CoEs that exist in some technologies and across markets, there is a need for an overarching Green Technology 'federation' to cohere efforts and remove duplication across the Shipbuilding Enterprise.

This is supplemented by the identification of 2 areas where it is noted that CoEs are lacking:

3 **Shore Infrastructure Development to support Net Zero** - Improved understanding of how to address shore infrastructure development whilst meeting the net-zero targets. (Discrete CoE)

4 **Retrofit of Existing Platforms** - A focus on retrofit of existing platforms to hasten the national decarbonisation journey. (Discrete CoE)

2 Ownership and Responsibility

The **Department for Transport (DfT)** have the lead role in decarbonising the shipping sector including incentivisation and national policy interventions. DfT owns HMG's flagship decarbonisation of maritime policy, the Clean Maritime Plan, and this strives to give industry clarity over the need to meet emissions targets and contribute zero GHG emissions by 2050.

HMG's largest financial support to decarbonisation of the maritime sector is through the **UK Shipping Office for Reducing Emissions (UK SHORE);** this resides within DfT. The NSO played a vital role in securing £206m funding over the previous spending period for UK SHORE, and the organisation dispenses funds aimed at medium and high TRL decarbonisation technologies through the CMDC and ZEVI programmes, respectively. This funding is there to support the introduction of technologies in to both new build and retrofit vessels.

The **Department for Business and Trade (DBT)** also has a significant stake in leading HMG's industrial policy, and any capital investment into infrastructure and driving up productivity/investing in advanced manufacturing techniques will benefit this sector. The **Department for Energy Security & Net Zero** strategy aims to secure long-term energy supply, reduce energy bills, and achieve net-zero emissions and, whilst there are no specific shipping policies, the department's actions impact the entire energy landscape, including maritime. The **Maritime and Coastguard Agency (MCA)** is actively engaged in advancing decarbonization efforts within the maritime sector and are responsible for implementing the majority of international conventions in UK waters. **Innovate UK**, part of **UK Research and Innovation (UKRI)**, supports business-led innovation across all sectors, technologies, and UK regions and this is especially relevant in decarbonisation.

3 Stakeholder Engagement

Further to the state bodies responsible for policies, the key stakeholders start with the Industry Associations such as **Maritime UK** and **Society of Maritime Industries (SMI)** who a key role in cohering individual activities and shaping national policies.

The industry stakeholders include shipbuilders, ship operators and their supply chains. Academic advancement is also essential.

Around the UK, a range of organisations and/or existing Centres of Excellence are already focused on developing Decarbonisation – Maritime Transition to Net Zero. The following list is not exhaustive:

- Appledore Clean Maritime Innovation Centre
- Clean Maritime Research Hub (DfT/led by Durham University)
- CPI - Energy Storage
- Energy Innovation Centre – WMG
- Energy Systems (ES) Catapult – Renewables
- Energy Catapult - Offshore Renewables Energy Catapult (OREC)
- ETZ - Energy Transition Zone (ETZ)
- Marine Energy Engineering Centre of Excellence (MEECE) - Delivered by: OREC (Offshore Renewable Energy Catapult)
- Port of Tyne Centre (Offshore Renewables) – Green Energy
- Powertrain Research Centre - Clean Energy Fuels
- UK National Clean Maritime Research Hub (UK-MaRES)
- University of Exeter (Centre for Future Clean Mobility (CFCM))
- University of Newcastle (Research Group: Marine Resources & Renewable Energy)
- University of Plymouth (Centre for Decarbonisation and Offshore Renewable Energy, Marine Station)
- University of Southampton - Maritime Futures
- University of Strathclyde - NAOME (Naval Architecture, Ocean and Marine Engineering)
- University of Strathclyde - PNDC (The Power Networks Demonstration Centre)

4 Strategic Rationale for Government Intervention

It is clear that given the challenge ahead, and significance of the values involved, that there are many policy and pseudo-policy bodies involved in the pursuit of maritime net zero. Creating an empowered overarching organisation to co-ordinate all existing efforts will add focus and drive. It is proposed there is a single policy focus through the DFT sponsored **Clean Maritime Council** and this needs to be backed by clear regulatory signposting and certification.

Similarly, there is a need to drive coherence across the wide range of existing CoEs. But moreover, they need to be deconflicted and acting with unity of purpose if the nation is to achieve its goals. Creating a **Maritime Green Technology 'Federation'** would acknowledge the various CoEs that exist across various technologies (Fuels, Machinery, Electrical, Propulsors, Hull forms) and markets (Cruise, Commercial Shipping, Defence, Ferries, Leisure, Offshore, Work Boat), and provide coherence to the CoE efforts and remove duplication.

There remain some gaps across the relevant CoEs, most notably in Infrastructure (Ports and Terminals) but there are Centres of Excellence across the UK which support thinking and best practice. Further thinking is required to develop the commercial model to create true CoEs.

5 Evidence Base

The need to address decarbonisation of the maritime sector is well evidenced and baked into national strategy.

The following provides an overview of existing evidence which supports and justifies the intervention:

- The Clean Maritime Plan – now updated to 'Voyage to Net Zero'
- Maritime Decarbonisation Strategy 2022 – Decarbonisation Technology https://decarbonisationtechnology.com
- "UK Domestic Shipping: Mobilising Investment in Net Zero" report, identifies funding mechanisms that can be applied immediately to unlock untapped investment capital to finance this transition, without waiting for the introduction of carbon pricing or the selection of a 'winning' zero emission fuel solution. (30 Nov 2022)

7 Options for Intervention

In order to meet HMG's policy of net zero GHG emissions from the domestic maritime sector by 2050, a coherent national approach is needed. That said, it is essential that we are cognoscente of the plethora of current activities and best practices that industry is bringing to the market, predominantly through commercial opportunities and therefore as Centres of Expertise. Centres of Excellence are also developing as the various possible technologies are explored and developed. There are clear choices to be made:

- **Do Nothing**: CoEs will proliferate, driven by market factors and the strength of views that one technology will prevail over another. Ultimately this will result in a chaotic approach which will simply defer the national ability to hot the policy targets.
- **Minimal Intervention**: Co-ordination and coherence of the existing activity.
- **Medium Intervention**: Extending above with incentivisation to address obvious holes on the CoE laydown.
- **Maximum Intervention**: A national level CoE which effectively brings together all efforts across the totality of markets, domains, technologies and parts of the lifecycle. This has been ruled out due being such a vast, unwieldy beast.

The minimal intervention has therefore been identified as creating an overarching body to co-ordinate the national journey to Maritime Net Zero. In terms of sponsoring such activity, which predominantly relates to the policy setting and subsequent national implementation of these policies, this would logically align with the UK Clean Maritime Council. Such alignment would be efficient and remove possible duplication through creating a new body.

It is also essential to note that various CoEs that exist in some technologies and within some markets. Rather than disturb what is an active and effective CoE ecosystem, there is a need for an overarching Maritime Green Technology 'federation' to cohere efforts and remove duplication.

Should further funding be available (Medium Intervention), it has been noted that CoEs are lacking in Shore Infrastructure Development to support Net Zero; there is a need to improve understanding of how to address shore infrastructure development whilst meeting the net-zero targets. And in the Retrofit of technologies to existing platforms.

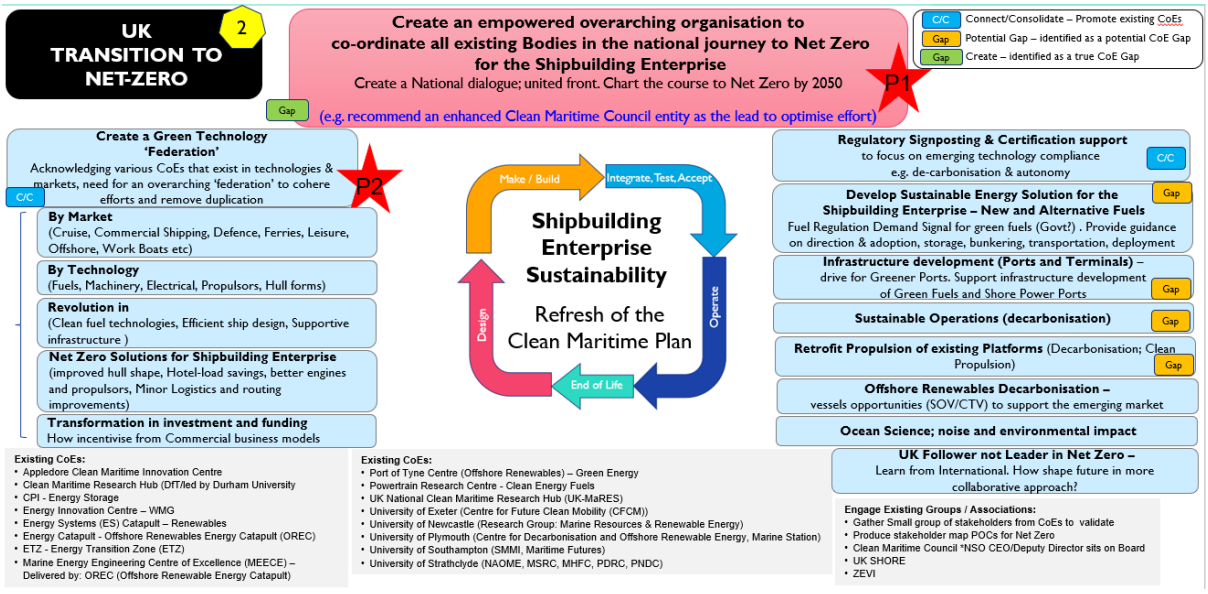
8 Recommendations

For minimum cost and maximum impact, the CoE T&FG recommendation is to focus on 2 key areas:

- Maritime Net Zero Overarching Body. Create an empowered overarching body to co-ordinate the national journey to Maritime Net Zero. It is noted that the Clean Maritime Council are ideally placed to assume this role.
- Maritime Green Technology 'Federation'. Acknowledging the various CoEs that exist in some technologies and across markets, there is a need for an overarching Maritime Green Technology 'federation' to cohere efforts and remove duplication.

This is supplemented by the creation of 2 CoEs to address specific areas that are lacking centralised approaches to the challenges:

- Shore Infrastructure Development to support Net Zero - Improved understanding of how to address shore infrastructure development whilst meeting the net-zero targets.
- Retrofit of Existing Platforms - A focus on retrofit of existing platforms to hasten the national decarbonisation journey.



ANNEX 5 – Recommendation Summary – Research and Innovation Institute

NSbS Centres of Excellence Gap Analysis – Summary Recommendation

THEME: Research & Innovation Institute

1 Executive Summary

The focus of this paper is on a proposed Research & Innovation Institute for the Shipbuilding Enterprise.

We propose that the UK should establish a 'Research & Innovation Institute' with the role of operating as a focal point for coordinating research and innovation activity for the shipbuilding enterprise and wider maritime industry. This role would comprise several aspects of national thought leadership and coordination, including

- alignment of public funding to national strategic needs
- engagement of industrial participation
- holding and maintaining a national Research, Innovation and Development roadmap
- achieving connectivity across established shipbuilding / maritime sector CoEs in the research and innovation space
- aligning generic (cross sector) research and innovation focused CoEs e.g. HVMC with national maritime need
- convening the UK shipbuilding enterprise academic network
- establishing and maintaining monitors of activity and effectiveness

Innovation is about turning new ideas, technology and processes into working practice, and in the maritime sector a key barrier to this transition is regulatory approval and certification. In addition to its thought leadership, coordination and innovation strategy role, the Research and Innovation Institute would also operate as a source of expertise, guidance and signposting on navigating regulatory barriers to innovation deployment.

In support of the NSbS strategic focus on Shipbuilding, it is recommended that the innovation institute has a scope in support of the full UK Shipbuilding Enterprise. This focus would maximise available national benefit while being manageable. This scope would also be more comparable with that of other sector focused innovation bodies.

Industry feedback from the roundtable events indicated that there are many current but uncoordinated centres of excellence across the UK which support the maritime sector, which could be more active in this industry, with scope to reduce duplication or non-strategic effort. Feedback also clearly indicated challenges in navigating the regulatory hurdles and the need for targeted support in this area. There could be significant value from the relatively low-cost intervention of coordinating and exploiting what has already been established (via the public purse) rather than creating new entities or capital projects. There is no recognised communication of national shipbuilding RD&I needs and therefore no coordinated means of getting these established entities to engage more with Shipbuilding Enterprise / maritime opportunities. Maritime Research and Innovation funding is allocated based on standard

academic excellence basis (novelty, uniqueness, research excellence) rather than need which means strategic issues are not consistently targeted.

The Research and Innovation Institute falls under the Ambition area of Productivity and overall competitiveness. Despite its well documented strengths in research excellence, the UK has an equally well documented challenge in innovation deployment, a recognised contributory factor in the UK's productivity challenge. From 2010 to 2022, the annual average growth in UK GDP per hour worked was just 0.5%, with little sign of improvement in recent years, and significantly lower than comparable economies including France, Germany and US. General observations on UK innovation deployment and productivity are mirrored in the Shipbuilding Enterprise as evidenced by industrial feedback, making the growth and successful exploitation of Research & Innovation a priority. There is a consensus across industry of the importance of a permanent solution to the challenges of exploiting research outcomes and delivering innovation in the maritime / shipbuilding sector and the potential for the UK to achieve greater productivity as a result, with the aim to build stronger collaborative working of existing CoEs in this area. Likewise there is a common concern across the industry related to intellectual property and commercial advantage. This latter point is a barrier to collaboration and therefore the progress of any national endeavour.

The proposal to establish a Research and Innovation Institute for the Shipbuilding Enterprise would address the situation perceived in the industry of short-medium term programmes of innovation support in the sector, but with more permanent organisations established in other sectors. It would be a cost-effective approach, aimed at leveraging existing investments and capability and directing expertise to the challenges of a sector which is vital to both the physical trade base and the national resilience of an island nation. The approach would also be somewhat innovative in itself, as the bringing together existing providers of research and innovation services into a collective national endeavour rather than creating dedicated new facilities, would differ from related approaches in other sectors.

2 Ownership and Responsibility

The Research and Innovation Institute could be delivered by a number of existing entities which should be enhanced to drive long term research and innovation. In the implementation phase, this requires further investigation into those organisations that already exist. These organisations should include Maritime Research and Innovation UK (MarRI-UK), Connected Places Catapult (CPC) and High Value Manufacturing Catapult (HVMC). We propose open, un-biased discussions with these organisations and others about taking on the role of the Innovation Institute, and to understand scope for enhancement and capitalising on the existing body of work. These discussions should inform the formal Business Case process. Proper analysis of commercial and management options should be undertaken. The enhancement of an existing body could include becoming a community of practice activity as an overarching body to provide scrutiny, governance and accountability.

The assessment should take account of the following points relevant to existing organisations.

- MarRI-UK is an industry-led membership organisation (facilitated by academia) tasked with driving the global competitiveness of the UK maritime through extensive partnerships in identifying, developing, and leveraging emerging technologies. Its members include most of the key Shipbuilders in the UK.

- MarRI-UK was created as one of the key institutions to drive Maritime Innovation in alignment with the UK Government's Maritime 2050 plan. As a key player in maritime research and innovation, it aims to drive UK shipbuilding strategic, and government policy, outcomes. Along with NSO it was created as a response to the NSbS.
- Evidence gathered during the establishment of MarRI-UK demonstrated the gap in this specific space, i.e. that there wasn't sufficient coordination of Maritime Ownership of the innovation space to drive progress. MarRI-UK is however a small entity which relies on a mix of public and industrial funding and needs to achieve greater critical mass if it is to be seen as a national coordinating body, with a long term stable future to enable long term thinking. Its current focus is coordination of players in the UK maritime academic network and is therefore more aligned with research than innovation. MarRI-UK is currently answerable only to its members (in terms of scrutiny, governance and accountability) and may require further constitutional / management development to take on further activity. Our initial assessment is that it has the potential to take ownership and responsibility if suitably adapted.
- The Connected Places Catapult (CPC) has recently established a Maritime & Ports theme, with some engagement in the Shipbuilding enterprise. Our initial assessment is that it also has the potential to take ownership and responsibility if suitably adapted. Other Catapults (esp. High Value Manufacturing (HVMC), Offshore Renewables (OREC)) occupy adjacent spaces, but do not address the Shipbuilding enterprise specifically.
- Other bigger coordinating/funding bodies exist in other comparable sectors e.g. Aerospace Technology Institute (ATI), and Advanced Propulsion Centre (APC) for automotive, but these do not have the relevant knowledge of Shipbuilding technologies.
- Trade bodies (Maritime UK and SMI) have an important part to play in feeding industry needs to the various government departments, but do not focus specifically on research and innovation which means that this topic is not a primary focus of attention. The senior Shipbuilding Enterprise Growth organisation, and the DfT / cross-departmental Maritime Council, have broad remits but would not be appropriate to operationalise Innovation in the terms we are proposing.
- MoD leads in this area of proposed scope (the National Shipbuilding Enterprise), as it convenes the NSO, but there is also clear overlap with DfT in certain areas based on their convening role in the Maritime Council. Overlapping and adjacent areas of government responsibility are as follows:
- NSO is responsible for overseeing implementation of the NSbS, which includes actions to develop innovation. It does not have a permanent initiative or function which would fulfil the role of a Maritime Research & Innovation Institute.
- Department for Transport (DfT) has established two important programmes, related to this topic, neither of which is a permanent solution, and both of which are focussed on only one (albeit important) aspect of innovation. The UK Shipping Office for Reducing Emissions (UK SHORE) was established 2022, but DfT said it was unable to commit, beyond 2025, to long-term investment in UK SHORE (*2). The UK National Clean Maritime Research programme (*3) (2023-2027) is focussed on academic input to emissions challenges (led by Durham University) funded by EPSRC/DfT.
- DfT is also responsible for delivering Maritime 2050 and related action plans, with a strong focus on decarbonisation as it has wider responsibility for Clean Maritime Policy and owns the Maritime Technology Agenda.

- DSIT's UKRI owns the budgets and support functions for Academic and Industrial Research, development and Innovation. Innovate UK funds CPC for its Milestone Programmes and provides c. £7.8M for the Maritime Milestone programme from 2022 to 2027 (5 years). MoD is responsible for undertaking its own Naval / shipbuilding related innovation, delivering the Royal Navy's technology roadmap through DE&S, NavyX, dstl, QinetiQ etc.
- Maritime and Coast Guard Agency (MCA) (owns the regulatory agenda)

*2 Maritime 2050: Government Response to the Committee's Fifth Report - Transport Committee (parliament.uk)

*3 Durham to lead new £21.3m research hub to decarbonise UK maritime sector - Durham University

3 Stakeholder Engagement

In the case of innovation, the key stakeholders start with the shipbuilding industrial and academic participants. The list also includes government funders of research and innovation (especially UKRI incorporating Innovate UK and research councils), RTOs in adjacent spaces including Catapults and, the major trade bodies (SMI and Maritime UK). Other government departments (including DfT, DESNZ, DBT, DSIT, MoD and Crown Estates - England, Scotland.) have important stakes in our success and would be on the list. The supply chain and technology vendors would be engaged. Regional factors are also important and local authorities, Freeports and industry clusters in major maritime locations will also be important.

Specifically, the proposed Research & Innovation Institute would engage directly with the incumbent research and innovation landscape. At academic research level there is a relatively small number of well-established Maritime or Shipbuilding focused research groups including those at the universities of Exeter, Liverpool, Liverpool John Moore's, Newcastle, Plymouth, Southampton, Strathclyde and UCL all of whom are members of MarRI-UK. There is a wider group including Aston, Birmingham, Brighton, City, Cranfield, Durham, Edinburgh, Heriot-Watt, Nottingham, Sheffield, Solent, St Andrews, and Ulster who are also involved in maritime or Shipbuilding programmes. Durham University is now host to the UK National Clean Maritime Research Hub (UK-MaRes Hub) and is also well engaged. Several RTO and innovation providers in adjacent sectors such as: Catapults for Offshore Renewable Energy, High Value Manufacturing and Connected Places; The Alan Turning and Henry Royce Institutes, and TWI are also important sources of capability that the Innovation Institute would align to shipbuilding and maritime needs and deploy.

Industry Stakeholders, including shipbuilders, ship operators and their supply chains, would be end-users and beneficiaries of the innovation institute outcomes. These would include, for example, BAE Systems, Babcock, APCL Group, Harland & Wolff, Ferguson Marine, SubseaCraft, BMT, Lloyds Register, QinetiQ, ARC, CMS, Ecomar, Newcastle Marine Services, Oasis Marine, Spaera, Walker Subsea. This includes members of MarRI-UK and companies which cooperate in defining the needs of, and funding for, shipbuilding research, development and innovation.

Various entities have regulatory roles in the sector and will be important stakeholders in enabling the regulatory support role. These include the Defence Maritime Regulator (DMR), The

UK Secretary of State's Representative (SAOSREP) appointed by the Maritime Coastguard Agency (MCA). In addition Industry Associations and trade bodies with a direct interest would include Maritime UK and the Society of Maritime Industries. MarRI-UK have already engaged DfT in early discussion on the concept of an ATI style organisation for the maritime industry and a white paper has been provided.

4 Strategic Rationale for Government Intervention

There is a clear need identified in the government's NSbS (and the "Refresh") for a centralised entity to coordinate solutions to government policy outcomes, spanning near term and over the horizon maritime research and innovation challenges, identify long term gaps, and address identified gaps in research and innovation, including its deployment. This is consistent with the establishment of a national Industrial Strategy. These strategic goals may be updated by the current Government initiatives under new Labour Mission for Economic Growth, including the Industrial Strategy and Strategic Defence Review. Shipbuilding expects to play its part in supporting this mission, contributing to Britain's comparative advantages in advanced manufacturing, green, technology and professional technical services.

In his Report from 2015 (Maritime Growth Study), Lord Mountevans highlighted that UK Science, Technology and Innovation are of underpinning importance to the UK Maritime Sector and are critical to maintain and strengthening the UK's position as an internationally competitive sector. It further highlighted that bringing together government, industry and research institutions in close collaboration is necessary to promote further growth in the sector.

Following closely on from Lord Mountevans' report, Sir John Parker's Report emphasised the need for a virtual Joint Innovation Centre for the marine industry and its customers, and included recommendations for areas of joint working, it also emphasised that "Given their design expertise, BAES, BMT, Houlder and Babcock Marine should play a leading role in participation in and secondment of specialists (project to project) to the new Innovation Centre to drive world class performance."

More recent Strategies such as the National Shipbuilding Strategy Refresh (Refreshed NSbS) and the Maritime 2050 Strategy also are clear on the need for the equivalent of an ATI - a Maritime Innovation Hub, learning from the existing Maritime Innovation Hub (MarRI-UK).

It is clear from the above that the UK maritime industry and shipbuilding enterprise requires a coordinated national research strategy with roadmap behind to support the research activities to bring UK to upfront of maritime development.

Current institutions, including those mentioned above, have not provided the answer and are only likely to do so with significant adaptation.

There is unlikely to be a purely industrial driven solution to this. We understand that industry has shown significant enthusiasm for the (mainly match funded) Innovation competitions that have been run by Innovate-UK and others. However, our experience is that self-funded innovation by companies is – understandably – very focussed on self-interest. Concerns over intellectual property and commercial sensitivity tend to exacerbate this issue. Government is best placed to encourage more strategic and more collaborative innovation and to facilitate purposeful interaction between academia and industry. There is no single company in the

sector which would be well positioned to deliver this effect, without concerns about competitive advantage.

Government intervention may be made easier by investing in an already proven solution (like MarRI-UK), using identified priorities, to evolve into an effective and recognised organisation to deliver the policy outcomes desired.

5 Evidence Base

The need for a Shipbuilding Enterprise sectoral approach is based on three key factors. First, the maritime environment is a "global commons" that enables our island's trade, communication and power projection, but presents unique challenges from long distances involved to complexity of modelling the dynamic forces of water on steel hulls. Second, the ability of the UK's maritime and shipbuilding industry to take financial risk on innovation is also a significant driver, with most innovative SMEs having limited capital/cash available. Third, the small number of large shipbuilders / ship repairers (which might be able to afford more R&I budget) are usually in direct competition, often for HM Government or international customers, which do not encourage a coordinated approach.

These issues have been behind the need for, and publication of, evidence in

- Maritime 2050: navigating the future - GOV.UK (www.gov.uk)
- National Shipbuilding Strategy - GOV.UK (www.gov.uk)
- Refresh to the National Shipbuilding Strategy (Refreshed NSbS) - GOV.UK (www.gov.uk)
- The UK's Academic Capacity and Capability for Shipbuilding Report

The last of these, the NSO sponsored Academic capability study, found that

- The UK has a leading position in key research areas including:
    - **Decarbonisation**: analytical strategies, energy-saving devices, alternative fuels and carbon capture.
    - **Ship design research**: ship systems optimisation, biomimicry for propulsion and ship control.
    - **Specialised ship types**: specialist vehicles and underwater vehicles (including remote/uncrewed)
    - **Autonomy and design**: focused on route optimisation and the development of intelligent systems.
- The UK has the greatest potential in adopting Industry 4.0 and 5.0[1] techniques into current shipbuilding activities

[1] The Industry 4.0, or the Fourth Industrial Revolution concept was popularised in 2016 by Klaus Schwab, Founder of the World Economic Forum and is based on expectation of a fundamental transformation in the global industrial landscape enabled by cyber-physical systems including the internet of things, machine to machine communication, and artificial intelligence. The parallel is drawn with three earlier industrial revolutions enabled by mechanisation, electrification, and automation respectively. Industry 5.0 is an emerging industrial concept which aims to tackle human centric and societal concerns that can be associated with digitally enabled transformation. There is currently some lack of consensus over Industry 5.0 definitions, but the societal concerns can include issues like human interaction / involvement in digitally transformed industrial systems and sustainability impacts from ever increasing industrial efficiency.

- The UK has a significant opportunity in lean manufacturing and large-scale additive manufacturing techniques, optimising and producing more efficient methods of shipbuilding.
- The UK needs to focus its maritime research into autonomy, decarbonisation, innovative technology (including IoT, digital twins & additive manufacturing) and the maritime application of industry 4.0, utilising these research areas to achieve enhanced global competitiveness.
- Competitor nations have common focus areas for research.

More recently, the NSbS CoE T&FG round table meetings provided further, ongoing, anecdotal evidence of this need, and the misalignment between maritime innovation and those of other industry sectors is a matter of public record. Despite its undeniable importance, whereas other comparable industries benefit from substantial targeted research funding and coordination mechanisms (Automotive £1bn and 10 year commitment to APC, Aerospace ~£700m commitment to ATI), maritime receives limited support (£206m for UK SHORE is by far the largest commitment) and no focal point for coordination and collaboration across industry and academia aligned to delivering UK government policy.

The remaining evidentiary gap is in the potential for commitment of resources (private and public). Further work is required to develop a sound basis on which industrial and government partners (identified elsewhere in this paper) can build business cases for taking action.

6 Options for Intervention

We have not undertaken a cost and economic assessment of the proposed Research and Innovation Institute, and - while something akin to the ATI in aerospace would seem to be the most desirable from the industry perspective - it is clear that issues of affordability and priority need to be fully considered. The following text however, provides three-point options for size, scale and scope of a Research and Innovation Institute:

- **Do Nothing:** With no intervention the Research and Innovation landscape will operate as it does today with some important and globally recognised programmes and islands of excellence around the UK. MarRI-UK in its current form will continue (subject to ongoing funding) to provide light-touch coordination and reporting of progress in strategic importance. Critically there will be no basis to respond on a strategic and nationally coordinated basis to the time-bound and generational challenges of national resilience and decarbonisation.

- **Minimum intervention** - The minimum standard for an innovation institute acting to become national custodian of research and innovation strategy for the Sector would be creation of a national research and innovation roadmap. This would be developed based on broad outreach and workshop programme to ensure proper reflections of industrial and socio-economic needs. It would allow established activities including relevant CDTs, the Clean maritime hub, and more generic capabilities and programmes in the wider innovation ecosystem to be linked to overarching goals, and the 'white spaces' where no capabilities or programmes currently exist identified. Three areas of qualifying activity would also need to be pursued under this level of intervention

i. An economic evaluation (noting as incomplete above) would need to be undertaken on the unaddressed potential from the Sector based on a current level of investment and coordination in maritime research and intervention
ii. Point i) should be accompanied by an assessment of the propensity of the UK Maritime and Shipbuilding enterprise to co-invest at comparable levels to the exemplars of the aerospace and automotive sectors
iii. The issue of concern over intellectual property would need to be evaluated in terms of the extent to which it represents a barrier to progress on collaborative activity. There would be value it drawing comparison between maritime and more IP-savvy sectors in this regard and exploring the potential to educate incumbent and emerging organisations in more progressive approaches.

These would be an obvious precursor to confirmation of scope and identification of priority research themes and would be a major stepping-stone from today's somewhat fragmented approach into a programme which can be aligned to national need. It would address the need for coordination of activities and signposting of capabilities while avoiding the costly dedicated investment in new capital and infrastructure. In addition the need to provide guidance and signposting on regulatory requirements and their resolution would be addressed by a small team of specialised support staff. This would be a major driver of cost effectiveness and naturally illustrate where existing programmes and capabilities are essential to the sector and in some cases, help strengthen the case for their support.

The minimal solution would follow existing Government Dept lead (DfT), enabled by MarRI-UK and supported by NSO and SEG (Shipbuilding Enterprise for Growth) endorsement. All sector stakeholders would follow a government lead, which may be not sufficiently effective. Collaboration between industry and government would be as patchy as it is currently.

With a roadmap, its update and maintenance protocol, and deployment mechanism in place via the innovation institute the next level of intervention, as illustrated by analogy with ATI for aerospace, would be establishment and deployment of a funding allocation sized to address the identified gaps (from the roadmap).

- **Medium Intervention** - Undertaking (through direct involvement of industry players, academics and RTOs) targeted studies equivalent to the ATI FlyZero programme aimed at positioning UK R&D&I in a particular problem space against a national vision. This would allow a direct line of sight between gaps and issues identified through the national roadmap and the definition of approaches in the form of technology insertion, regulatory progression, new infrastructure, and design approaches and standards. Intervention at this level would be distinct from the conventional open competition-based research funding mechanism on the basis that alignment to identified national need would be a primary selection criterion.

- **Maximum Intervention** - Allocation of a more general funding stream aligned to the industry needs and the roadmap. Likely to primarily be innovation (mid TRL) rather than fundamental research (low TRL) focused funding, a view which reflects the role of UKRI in providing investment in research and innovation and support for researchers and businesses, funding which is rightly allocated based on criteria such as novelty and research excellence. Like ATI, a portion of funding could be made available against nationally significant capital and infrastructure needs in the maritime research space.

An ATI style approach deployed through a maritime institute would enable a coordinated direction of funding based on national maritime research strategy, as articulated in the roadmap, to support industry development, while also considering needs for international competitiveness. It is also tailored to today's circumstance through the clear intent to build on existing entities and investments and avoid duplication of spend where possible. In developing the concept we would aim to proactive seek learning from ATI and AGP as well as other collaborative networks such as the Henry Royce Institute and the Catapult network so that we build on the extensive national learning that has been developed in the innovation space other the last decade.

The Innovation Institute maximum intervention would involve collaborative development, facilitated by the new Research and Innovation Institute and including key government departments and industry leaders, of an HMT/Green Book quality business case. This would address joint funding to intervene in the government pipeline, promoting and funding the adoption of the Research & Innovation Institute to close the UK gap on this capability. A suitable candidate would be tasked by SEG to develop a more active / co-ownership stance with DfT (as lead for the Maritime Council) on this Research & Innovation Institute agenda. Industry and NSO would be asked at the Strategic Case stage to confirm in principle willingness to co-own the funding schemes for the Institute. In addition to direct grant funding for early operating costs, the Business Case would address access to other finance mechanisms, gearing in greater private sector funding. It would also include relevant international and other sector Case Studies (e.g. ATI) which support a credible logic model to show how such funding would create technology implementation and lead to increased productivity and economic growth.

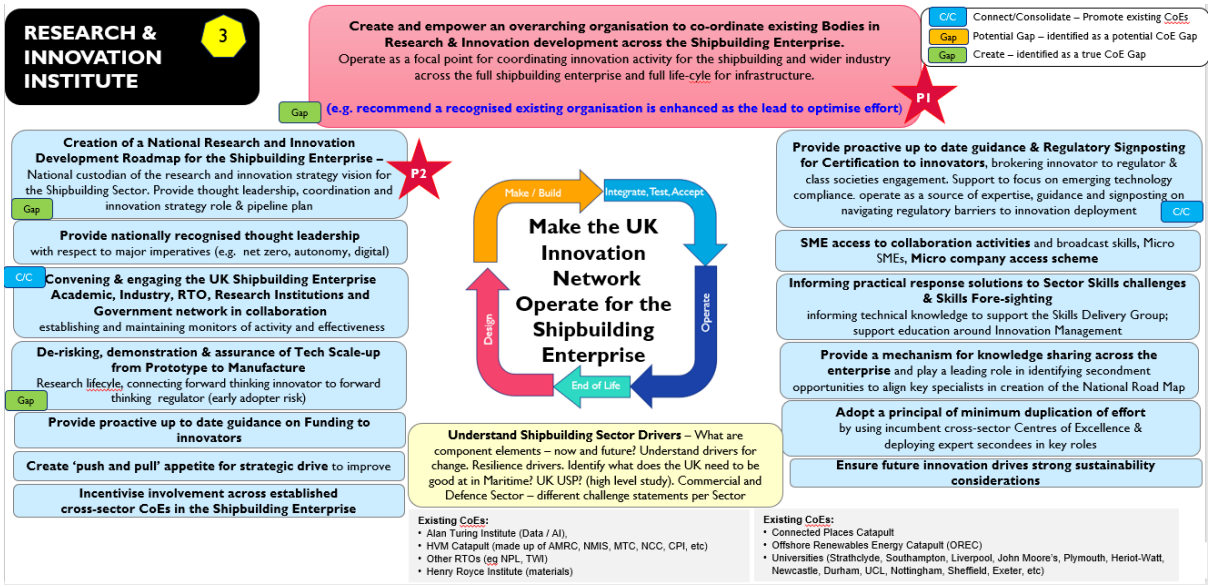
7 Recommendations

We have one recommendation:

The NSO should establish a subsidiary 'Research & Innovation Institute' with the role of operating as a focal point for coordinating and managing research and innovation activity for the shipbuilding enterprise and wider maritime industry.

This role would include alignment of public funding to national strategic needs, engagement of industrial participation, holding and maintaining a national Research and Development roadmap, achieving connectivity across established shipbuilding/maritime sector CoEs, aligning generic (cross sector) CoEs e.g. HVMC with national need, convening the UK maritime academic network, establishing and maintaining monitors of activity and effectiveness.

In order to deliver this, we anticipate that a full Green Book compliant business case will be required, starting with a task on MarRI-UK to develop the Strategic Case and Funding assessment.


RESEARCH & INNOVATION INSTITUTE
3
Create and empower an overarching organisation to co-ordinate existing Bodies in Research & Innovation development across the Shipbuilding Enterprise.
Operate as a focal point for coordinating innovation activity for the shipbuilding and wider industry across the full shipbuilding enterprise and full life-cyle for infrastructure.
Gap
(e.g. recommend a recognised existing organisation is enhanced as the lead to optimise effort)
P1
C/C Connect/Consolidate – Promote existing CoEs
Gap Potential Gap – identified as a potential CoE Gap
Gap Create – identified as a true CoE Gap
Creation of a National Research and Innovation Development Roadmap for the Shipbuilding Enterprise – National custodian of the research and innovation strategy vision for the Shipbuilding Sector. Provide thought leadership, coordination and innovation strategy role & pipeline plan
P2
Gap
Provide nationally recognised thought leadership with respect to major imperatives (e.g. net zero, autonomy, digital)
C/C
Convening & engaging the UK Shipbuilding Enterprise Academic, Industry, RTO, Research Institutions and Government network in collaboration establishing and maintaining monitors of activity and effectiveness
De-risking, demonstration & assurance of Tech Scale-up from Prototype to Manufacture Research lifecyle, connecting forward thinking innovator to forward thinking regulator (early adopter risk)
Gap
Provide proactive up to date guidance on Funding to innovators
Create 'push and pull' appetite for strategic drive to improve
Incentivise involvement across established cross-sector CoEs in the Shipbuilding Enterprise
Make / Build
Integrate, Test, Accept
Operate
End of Life
Design
Make the UK Innovation Network Operate for the Shipbuilding Enterprise
Provide proactive up to date guidance & Regulatory Signposting for Certification to innovators, brokering innovator to regulator & class societies engagement. Support to focus on emerging technology compliance. operate as a source of expertise, guidance and signposting on navigating regulatory barriers to innovation deployment
C/C
SME access to collaboration activities and broadcast skills, Micro SMEs, Micro company access scheme
Informing practical response solutions to Sector Skills challenges & Skills Fore-sighting informing technical knowledge to support the Skills Delivery Group; support education around Innovation Management
Provide a mechanism for knowledge sharing across the enterprise and play a leading role in identifying secondment opportunities to align key specialists in creation of the National Road Map
Adopt a principal of minimum duplication of effort by using incumbent cross-sector Centres of Excellence & deploying expert secondees in key roles
Ensure future innovation drives strong sustainability considerations
Understand Shipbuilding Sector Drivers – What are component elements – now and future? Understand drivers for change. Resilience drivers. Identify what does the UK need to be good at in Maritime? UK USP? (high level study). Commercial and Defence Sector – different challenge statements per Sector
Existing CoEs:
• Alan Turing Institute (Data / AI),
• HVM Catapult (made up of AMRC, NMIS, MTC, NCC, CPI, etc)
• Other RTOs (eg NPL, TWI)
• Henry Royce Institute (materials)
Existing CoEs:
• Connected Places Catapult
• Offshore Renewables Energy Catapult (OREC)
• Universities (Strathclyde, Southampton, Liverpool, John Moore's, Plymouth, Heriot-Watt, Newcastle, Durham, UCL, Nottingham, Sheffield, Exeter, etc)

ANNEX 6 – Recommendation Summary – Future Platform Power & Propulsion

NSbS Centres of Excellence Gap Analysis – Summary Recommendation

THEME: Decarbonisation – Future Platform Power & Propulsion

1 Executive Summary

The focus of this Annex is on **Future Platform Power & Propulsion**, a domain that contributes significantly to the wider success of the maritime ecosystem and shipbuilding industry, and one of the highest value vessel systems within the shipbuilding enterprise. This falls under the Ambition area of **Green Technology** with wider impacts on Productivity and Skills/Capability.

Context for UK: Maritime power and energy is an intrinsic enabler of maritime missions, vessel operational performance and competitive advantage, but which also has the greatest direct impact on GHG emissions and the path to net zero through the fuels consumed by the equipment currently available. The UK has some world-leading capability in the power systems domain (especially specialist applications, larger prime movers (gas turbines), electrification and power and energy system integration), but also a high level of dependence on international providers of mass market prime movers too. **The aim is to build stronger collaborative working of existing CoEs in the area of power and propulsion, leveraging potential funding support towards UK industry being a key stakeholder in cleaner, next generation solutions.**

HMG's policy for marine decarbonisation, outlined in the Clean Maritime Plan and its forthcoming refresh, sets a clear, ambitious, goal of net zero greenhouse gas (GHG) emissions from the domestic maritime sector by 2050, with the objective of reducing the sector's lifecycle emissions close to zero. Reaching Net-Zero shipping emissions by 2050 will require a real focus on realisation of maritime power and energy technologies, including new-fuel-ready engines or energy devices, power and electrical systems.

Industry consensus, current gap and opportunity:

- Through the consultation process for CoEs with key stakeholders, feedback from the leisure sector identified UK disadvantage and supply chain constraint through dependence on overseas providers of powertrain equipment. Specifically, this relates to current frustrations in securing commercial, supply or technical modification influence over the large providers of [typically diesel] internal combustion engines, used as both propulsion prime movers or power generators. Providers of such engines typically supply other sectors (automotive, industrial) at much higher volume. Whilst this issue was identified by the leisure craft sector, it's one recognised more broadly in the maritime sector for larger vessels.
- However, it's not clear what difference a CoE can make in this regard - building UK technical or manufacturing capability to onshore supply of [diesel] ICEs would still present issues of achieving cost-competitiveness through sufficient volume. It would also represent a focus on solutions that don't reflect the shift towards decarbonisation. So, it's recommended that the underlying issues should be explored further through industry bodies.
- Therefore, this Recommendation acknowledges the importance of the power and propulsion issue for some segments, but advises it being considered an opportunity for

***future* power and propulsion**. This reflects the CoE T&FG view that effort will be better placed focusing on improving the UK's position in forward-facing technologies and capabilities.

The CoE Recommendations for Future Platform Power & Propulsion is to focus on five key areas that align with the needs of priority maritime segments to drive operational, environmental and commercial viability:

- **A Working Group** leveraging Net Zero / clean maritime structures and signposting existing CoEs to support acceleration of power and propulsion solutions.
- **Alignment with the identified Net Zero CoE** pillar recommended by the T&FG. The UK could still have an opportunity to accelerate progress or develop IP in next-generation prime movers (and the link to cleaner fuels) or energy devices, supported by a net zero-focused CoE (extant or new).
- **A cohesive capability or technology development agenda** that focuses on the most impactful gaps as they relate to viable, relevant segments for the UK shipbuilding enterprise and its export opportunities.
- **Consider retrofit and new build** requirements in defining focus areas, including operational-readiness levels as much as technology-readiness. Including close engagement with the shipbuilding, classification and regulatory communities, and incentives for pilots that de-risk and encourage adoption.
- **Strengthen maritime sector visibility** at government level to support its needs and opportunities being considered in cross-sector initiatives that could further support this effort but in a more coordinated and collaborative way. For example, opportunities for the leisure sector to benefit from collaborating with CoEs in adjacent sectors, like the automotive Advanced Propulsion Centre (APC) and the Cross-Sector Battery Systems Innovation Network.

2 Ownership and Responsibility

- DfT's wider responsibility for Clean Maritime Policy and Clean Maritime Planning will help to drive change for the sector, and the move towards a zero-carbon maritime sector will necessitate vessel replacement as well as retrofitting. It's important that the maritime sector has continuity of attention, recognition and support afforded to other sectors, like aerospace.
- HMG's largest financial contribution to cleaner power and propulsion technologies for the maritime sector currently is through the UK Shipping Office for Reducing Emissions (UK SHORE), within DfT. The NSO played a vital role in securing £206m funding over the previous spending period for UK SHORE. The programme has supported UK innovation towards 'clean maritime' but there is a sector imperative for a viable way ahead towards commercialisation at scale.
- The UK shipbuilding and equipment industry has an opportunity to take advantage of the support available, including through its own investment, but welcomes more support. 'Competing' maritime nations, for example Norway, have provided significant investment and incentives for their industries to pull through new technologies to maturity.

- DfT (and more specifically the MCA and class societies) also have a role in regulation and approval, and so engagement here to remove barriers to manufacture and commissioning may be relevant.
- Clean Maritime Plan refresh and Clean Maritime Council 'leadership' will provide an important demand signal to stimulate a need for change and cohesiveness across the maritime ecosystem and its stakeholders (fleet owners, builders, ports, fuelling, equipment providers).
- Equally engagement across industry and trade bodies can help to bring timely consensus to technology options for future power and propulsion equipment requirements where there is currently no clear path forward.
- UK industry and trade bodies (including the government's DBT) can help to align the UK with the international maritime sector requirements for future power and propulsion solutions. Success for UK industry across its supply chain can only be built on creating solutions that are viable, scalable and competitive for international markets, whilst also recognising segments the UK can most practically compete and lead. DBT can support in continuing to encourage collaborative partnering in technology development programmes.
- DESNZ (ultimately responsible for HMG's Renewables Strategy) has an important role in defining the agenda around e.g. fuels and infrastructure which impact the maritime sector.
- The House of Commons Environmental Audit Committee has also released a [May 2024] report, Net Zero and UK Shipping which evaluates government progress in respect of UK domestic and international shipping, highlights some of the themes discussed in this report about UK sector's competitiveness in the international market and advocates the need for the Clean Maritime Plan refresh.

3 Stakeholder Engagement

There are a range of organisations and/or existing Centres of Excellence focused on or working on initiatives relating to maritime power and propulsion, including those primarily for net zero solutions. This includes, for example:

- Appledore Clean Maritime Innovation Centre
- Clean Maritime Research Hub (DfT/led by Durham University) - recently announced during LISW
- Energy Catapult - Offshore Renewables Energy Catapult (OREC)
- Marine Power Test Facility (GE Vernova)
- Powertrain Research Centre - Clean Energy Fuels
- UK National Clean Maritime Research Hub (UK-MaRES)
- University of Exeter (Centre for Future Clean Mobility (CFCM))

There are also a range of Industry Associations that could be engaged:

- Maritime UK
- MarRI UK
- Society of Maritime Industries (SMI)
- IMarEST

4 Strategic Rationale for Government Intervention

Maritime power and propulsion is a domain that contributes significantly to the wider success of the maritime ecosystem and shipbuilding industry, and **one of the highest value vessel systems within the shipbuilding enterprise** which benefits from export potential on both UK and overseas platforms. This falls under the Ambition area of **Green Technology** with wider impacts on Productivity and Skills/Capability.

Maritime power and energy is an intrinsic enabler of maritime missions, vessel operational performance and competitive advantage, but which also has the greatest direct impact on GHG emissions and the path to net zero through the fuels consumed by the equipment currently available.

The UK has some world-leading capability in the power systems domain (especially specialist applications, larger prime movers (gas turbines), electrification and power and energy system integration), **but also a high level of dependence on international providers** of mass market prime movers too.

Considering the global shift towards maritime net zero technologies and the supporting regulation to effect it, there is a significant requirement for a new generation of power and propulsion technologies to become available across the range of maritime segments, from smaller leisure, passenger and workboat vessels to larger transport, offshore energy, naval and passenger vessels.

With the UK's heritage in power and propulsion technologies, UK industry and supply chain has a window of opportunity to carve out a position as the market resets around new technologies. Such capabilities also bring the potential for high-value and high-skilled jobs and export opportunities, as well as making an important contribution to the transition to new zero objectives in maritime and adjacent sectors.

Challenges will remain in the UK's ability to scale and be competitive against established international providers of prime movers (e.g. in APAC) but securing UK early advantage in technology and intellectual property could create an exploitable business model as a baseline for UK industry to benefit from the energy transition.

5 Evidence Base

- UK Clean Maritime Plan – now updated to 'Voyage to Net Zero'
- UK National Shipbuilding Strategy Refresh (Refreshed NSbS)
- DfT UK SHORE / Clean Maritime Demonstration Competition aims and objectives
- "UK Domestic Shipping: Mobilising Investment in Net Zero" report
- Royal Navy Surface Platform Capability Roadmap (Power & Energy)
- OECD Analysis of the Marine Equipment Industry and its Challenges ('23)
- DNV Maritime Forecast 2050 ('23)

6 Options for Intervention

Maritime power and propulsion (and power systems for adjacent sectors) are a key element of the shipbuilding enterprise. Presence, or leadership, in this domain can help to secure the UK's position in shipbuilding and in shipbuilding's supply chain. With the momentum and disruption driven by a transition to net zero, **it is clear that viable, cleaner power and energy technologies will be an important determining factor in both equipment and platform selection, and therefore commercial success.**

Evidence from other sectors (like automotive and the energy sector) indicate that both government intervention and collaborative enablers can help to shift industry from lower TRL options to mature and viable solutions, across the recognised 'valley of death'.

The following highlight the potential opportunities for and impact of a centre of excellence approach and wider interventions.

- **Do nothing:** UK vessel, OEMs and integrators will continue to be largely dependent on overseas supply base and the commercial and availability constraints that brings.
- **Minimal intervention:** UK SHORE funding and academic sector interest has stimulated ideas and options, but there is a risk that there is proliferation of lower TRL solutions with little consideration for viability or pull through to platform pilots. Minimal intervention, therefore, requires coordination of sector requirements and existing activity.
- **Medium intervention:** improved framework and funding for CoEs and their collaboration and incentives for platform pilots. Support for the wider maritime sector net zero transition (fuels, infrastructure) as enablers to power and propulsion viable solutions.
- **Maximum intervention:** clean maritime funding extension that incentivises UK development, capability and adoption in a timely way.

7 Recommendations

Considering existing CoEs, the recommendation for an overarching body Maritime Net Zero body, and recent Clean Maritime grant funding, minimal intervention can be easy to effect but may not realise commercially viable solutions without support of incentives under medium or maximum interventions.

Propose as a 'project' or 'programme' (commission to conduct a feasibility study to look at power & propulsion to deliver as an intervention which could lead to a CoE.

FUTURE PLATFORM POWER & PROPULSION 4

Create a collaborative strategy & road map to future power and propulsion capabilities as a working group leveraging **Net Zero / Clean Maritime & building UK capability** structures and **existing COEs** to support acceleration of developments towards market-focused solutions *(demand fuels solution)*

Gap *Focus on technology- and operational-readiness of viable, next-generation capabilities*

P1

Propose as a 'project' or 'programme' (a commission to conduct a feasibility study to look at power & propulsion to deliver XX? intervention which could lead to a CoE

P2

Alignment with needs of identified, priority Shipbuilding Enterprise segments to drive operational, environmental and commercial viability

Collaboration with manufacturing expertise, considering cost and scale challenges (materials, additive, etc). Identify critical components

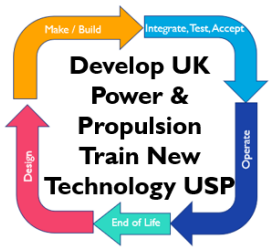
Collaboration with end user – design for functional, supportability & lifecycle expectations

New build and retrofit considerations aligned with ship and boat building community

Collaboration with energy source and future fuels knowledge-base, development and availability

Develop Green Technology - future solutions for Vessels

Commercial Readiness Levels to proper market launch – business model investment commercial development



Collaboration with Supply Base, incl. with other market segments for components and sub-assemblies

Exploit UK integration and test COE capabilities to derisk at system level (e.g. P&P tech from different providers for SOSA)

Shipbuilder pilots, classification, regulatory and fuels engagement

Classification and regulatory engagement

Sustainability considerations, e.g. materials and disposal

Centres for Retrofit Propulsion – Infrastructure development (Yards/Shipyards/Ports)

Existing CoEs:
- Clean Maritime Research Hub (DfT/led by Durham University
- Energy Innovation Centre – WMG
- Manufacturing Technology Centre - MTC
- Energy Systems (ES) Catapult – Renewables
- Marine Energy Engineering Centre of Excellence (MEECE)

Existing CoEs:
- Powertrain Research Centre - Clean Energy Fuels
- University of Exeter (Centre for Future Clean Mobility (CFCM))
- University of Strathclyde - PNDC (Power Networks Demonstration Centre)
- GEV Marine Power Test Facility (MPTF)
- Advanced Propulsion Centre (automotive)

Programmes and initiatives / ZEVI
- UK SHORE / CMDC
- Operation Net Zero (OREC)
- UKRI
- Driving the Electric Revolution
- Faraday challenge