Project

EAPA-0008/2022 - BLUESKILLING INNOVATION

WP 3- Matching supply and demand. Identification of training and skills gaps and needs

European Union Atlantic Area Report

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Summary

This report presents and applies a methodology for identifying and assessing training supply gaps relevant to the technological development of the maritime industry. It compares the findings of WP1 (industry needs) and WP2 (existing training and skills supply) to highlight key discrepancies between current curricula and regional skill demands. The outcome is a consolidated list of skill gaps, which will inform the collaborative development of new curricula and training modules in WP4.

The methodology comprises two main steps. First, the essential skills that are either insufficiently addressed or entirely lacking in current training offerings at the regional level are identified. Second, a multi-criteria decision-aiding approach is applied to prioritize the skills that most urgently require the development or revision of training programs.

Based on this analysis, two targeted training programs are proposed: "Smart Maintenance of Ships and Offshore Systems" and "Smart and Sustainable Ship Design and Operation." These programs address 41% and 33% of the identified critical skills, respectively.

The report concludes with key recommendations for educational and industry stakeholders to support technological innovation, decarbonization, and digital transformation across the maritime sector.

1. SCOPE

This WP3 report proposes and implements a robust methodology for identifying training needs in the maritime industry of the European Union's Atlantic Area. It builds on a comprehensive assessment of the existing educational offer (WP2) and the evolving skill demands of the maritime sector (WP1). The work encompasses two main objectives. First, it identifies skills that are either not covered by existing training programs or are inadequately addressed, highlighting gaps between educational supply and industry demand. Second, it applies a structured multi-criteria decision-aiding approach specifically the Deck of Cards Method (DCM), to prioritize the skill gaps that require the most urgent attention. This method incorporates expert input, value functions, and weighted criteria to support informed and strategic decision-making in training program development or revision.

Based on the outcomes of the analysis, two targeted training programs are proposed: *Smart Maintenance of Ships and Offshore Systems* and *Smart and Sustainable Ship Design and Operation*. These programs collectively cover a substantial portion of the identified critical skills (41% and 33%, respectively) and are intended to support the maritime sector's adaptation to current and future technological challenges.

The methodology and all findings are described in detail. Chapter 3 focuses on the identification and assessment of skill gaps in relation to regional training offers. Chapter 4 introduces and applies the Deck of Cards Method to prioritize skill development needs. Chapter 5 summarizes the results and provides practical guidance for the implementation of targeted training initiatives.

2. IDENTIFICATION AND ASSESSMENT OF REGIONAL SKILLS NEEDS AND TRAINING GAPS

This chapter focuses on identifying and assessing the skills and training gaps in the maritime sector by comparing the needs of companies (WP1) with the existing training supply (WP2). The key objectives are to identify areas where the curricula need updates or where new training programs should be developed.

The specific goals include identifying skills and training gaps between the university and vocational training supply and the needs of companies, as well as determining which professional profiles require curriculum updates.

2.1 Methodology

A methodology has been developed to identify and assess regional training and skills gaps and needs between the university and vocational training supply and industry needs. The goal is to gather information and carry out a regional analysis to pinpoint the specific skills and professional roles that are currently underserved by existing educational offerings.

The analysis relies on two primary data sources. The first is the results of a survey that provided detailed insights into industry demand and identified both current and emerging skill requirements across various segments of the maritime domain. The second source is the training supply data from Chapter 3, which documents detailed information on existing training programs. This includes educational content from universities, vocational training centers, and other relevant education providers.

A structured Excel spreadsheet titled "WP3_A - List of skills and training gaps and needs" has been developed to capture a wide range of relevant information for the identification and assessment of regional skills needs and training gaps (Figure 1 and Figure 2). The spreadsheet is divided into 3 main groups of data. 1) Skills and training needs (from an industry survey on skill needs) 2) Skill assessment (Figure 1); 3) Assessment of existing training supply (Figure 2).

WP1: Skills and training needs (Survey)				Skill assessment							
Sector	Skill	Service	Role	Challenge impact		Skill Contribution		Target education level	Training providers	Type of Training	Training Duration
				Digital Innovation Energy transition Maritime decarbonization	No impact Low Impact High Impact	Cybersecurity Virtual and augmented reality skills Data and analytics management Automation and robotics Skills related to the energy transition Decarbonization Logistics and supply chain management Navigation Energy Management ...	No impact Low Impact High Impact	Secondary education (EQF levels 3 & 4) Post-secondary (EQF level 5) High-level education (Bachelor EQF 6) High-level education (Master EQF 7) High-level education (Phd EQE 8)	Universities Vocational training centres Research centres Maritime industry SMEs ...	Initial Continuing Apprenticeship Regulatory ...	

Figure 1- WP3_A - List of skills and training gaps and needs 1) Skills and training needs 2) Skill assessment

WP2: Assessment of existing training supply																
Availability of training	1. Industry-Relevance of Training Content				2. Hands-On and Practical Training		3. Monitoring and Evaluation		4. Transferable Skills Training		5. Certification		6. Capacity to Upskill and Reskill		7. Scalability and Accessibility	
Not available Not adequate ...	Alignment with current industry needs	Use of Industry-Standard Tools	Sector-Specific Skills	Forecasted Skills Needs	Work-Based training	Simulations and Practical Labs	Skills Outcome Measurement	Continuous Improvement	Soft Skills and Core Competencies	Adaptability to Changing Roles	Recognition by Employers	Pathways to Advanced Credentials	Adaptability for Different Skill Levels	Lifelong Learning Opportunities	Broad Accessibility	Scalability for Growing Demands

Figure 2- WP3_A - List of skills and training gaps and needs 3) Assessment of existing training supply

In "1) Skills and training needs", the data is collected in terms of Sector, Skills, Services, and Roles. The sectors are the shipbuilding, offshore energy, merchant shipping, and fishing. The skills list includes cybersecurity, augmented reality, data analytics, and robotics, along with the services associated with each skill and the professional roles that require them.

For "2) Skill assessment", to better assess the alignment of the skills and training needs with this study's objectives, the spreadsheet assesses the level of impact each skill has on major challenges facing the industry, including digital transformation, innovation, energy transition, and maritime decarbonization. Additionally, it indicates the contribution of each skill to broader specialized skill targets, specifies the appropriate education levels for each skill, and lists the training providers along with the type and duration of the required training.

The methodology also evaluates the effectiveness of existing training programs using a set of predefined criteria in "3) Assessment of existing training supply". These criteria encompass the industry relevance of training content, ensuring alignment with current industry needs, the use of industry-standard tools, and a focus on sector-specific and forecasted skills. The assessment also examines the incorporation of hands-on and practical training elements, such as work-based learning options like apprenticeships and internships, as well as simulations and practical labs. Additionally, the presence of monitoring and evaluation mechanisms, including skills outcome measurement and continuous improvement practices, is considered. The extent to which programs offer training in transferable skills, like problem-solving and communication, and provide certifications recognized by employers will be evaluated. The analysis will further assess the support for upskilling and reskilling opportunities, ensuring adaptability for different skill levels and lifelong learning. Scalability and accessibility will be key factors, examining whether programs can be scaled up in response to industry growth and are accessible to a wide range of participants. Finally, the training's adaptability to changing roles and its ability to align with the evolving landscape of the maritime sector is considered to ensure comprehensive effectiveness.

Each regional team has completed the spreadsheet by conducting its own internal analysis, ultimately producing a focused and concise list of the main skill needs and training gaps identified in their area. By applying this structured methodology, the project aims to address the mismatch between available training and labor market needs in the maritime sector. The consolidated findings offer actionable insights to guide the development and refinement of training programs, ensuring they are better aligned with both current industry requirements and anticipated future trends (Appendix I).

2.1.1 Dataset characteristics

With all the regional lists completed and consolidated, this chapter conducts a comprehensive analysis of the collected data. This analysis not only highlights the unique skill needs and training gaps identified within each region but also reveals overarching trends and challenges shared across the entire European Union Atlantic Area. By systematically examining the findings, several key conclusions can be drawn.

Table 1, shows the distribution of skills and training needs across all regions. It reflects the number of responses obtained from each partner, highlighting both regional engagement and the relative scale of skill gap identification efforts.

Table 1- Distribution of skills and training needs across all regions

	Basque Country	France	Ireland	Portugal	Total
Identified Skill Gaps	154	15	10	26	205

- Basque Country: 154 out of 205 responses, **75.1%** of the total.
- France: 15 out of 205 responses, **7.3%** of the total.
- Ireland: 10 out of 205 responses, **4.9%** of the total.
- Portugal: 26 out of 205 responses, **12.7%** of the total.

These numbers show a significant concentration of responses from the Basque Country, which alone accounts for more than three-quarters of all identified skill gaps. Portugal follows at a distant second, while France and Ireland contribute smaller shares. This distribution may reflect differences in regional priorities, the scale of the workforce, or a more focused data collection approach among partners. The predominance of responses from the Basque Country provides a robust foundation for analyzing skill gaps in that region, while also inviting a comparative perspective across the partner countries.

2.1.2 Sector analysis

Table 2 and Figure 3 present the percentage of skill needs by sector (Shipbuilding, Offshore energy, Merchant shipping, and Fishing) across the four regions, Basque Country, France, Ireland, and Portugal, along with the overall total for each sector.

Shipbuilding stands out as the main sector in total, accounting for 37.6% of skills demand. This high demand is particularly evident in Portugal (50%), France (46.7%), and the Basque Country (37%). In contrast, Ireland shows 0% demand for shipbuilding skills, reflecting the absence of a shipbuilding industry in its economy.

Offshore energy is the next main sector in terms of skills demand, across the regions. Ireland leads with a 40% demand for offshore energy skills, which highlights the country's strategic focus and investment in renewable marine energy. The other regions also report moderate needs, aligning with the broader European goals towards green transitions in maritime sectors.

Skills in the merchant shipping and fishing sectors are less needed on average, with merchant shipping at 17.1% and fishing at 15.1%. Fishing shows the lowest total demand, with France reporting no need for fishing skills (0%). Ireland, meanwhile, places more emphasis on merchant shipping standing and offshore energy, with 40% for both, than on fishing, reflecting its sectoral priorities.

Fishing skills are generally in low demand, with some need in the Basque Country and Ireland, but minimal or no demand in France and Portugal, likely due to sectoral and economic priorities.

In summary, shipbuilding emerges as the main sector with highest skills demand, while fishing is the least needed. Ireland's lack of shipbuilding skills demand is directly tied to the absence of a shipbuilding industry, illustrating how regional economic structures shape workforce requirements.

Table 2- Distribution of skills and training needs across all regions by sector

Sector	Basque Country	France	Ireland	Portugal	Total
Shipbuilding	37.%	46.7%	0%	50%	37.6%
Offshore energy	29.9%	26.7%	40 %	30.8%	30.2%
Merchant shipping	14.9%	26.7%	40 %	15.4%	17.1%
Fishing	18.2%	0.0%	20 %	3.9%	15.1%

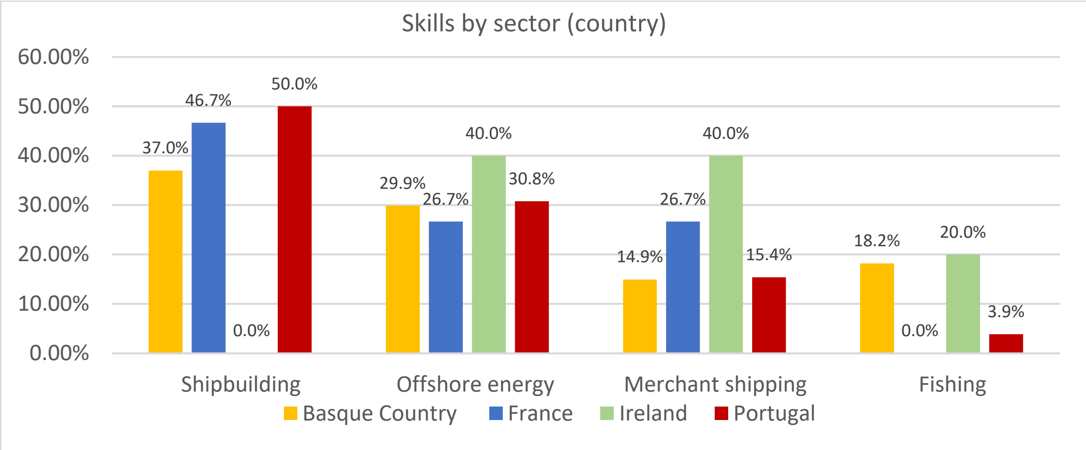

Figure 3- Distribution of skills and training needs across all regions by sector

2.1.3 Training provider

Table 3 and Figure 4 illustrate the types of training providers identified as necessary to address skills gaps in the maritime sector across the Basque Country, France, Ireland, and Portugal, as well as the overall average for each provider type.

Universities emerge as the primary providers needed to fill training gaps, accounting for 59.5% of the overall need. This trend is especially pronounced in Portugal (92.3%) and Ireland (80%), indicating a strong reliance on higher education institutions. The Basque Country (54.6%) and France (40%) also show significant, though comparatively lower, reliance on universities.

Vocational training centres are the second most needed providers, representing 40% of the overall demand. Their importance is highest in France (60%) and the Basque Country (45.5%), where practical, hands-on skills are more often delivered through vocational channels. In contrast, Ireland (10%) and Portugal (7.7%) show much less dependence on vocational training centres.

Research centres are notably absent from the list of needed providers, with 0% reported across all regions. This suggests that, while research institutions may contribute to innovation and knowledge generation, they are not currently seen as central to direct skills training for the maritime workforce.

Maritime industry SMEs (small and medium-sized enterprises) play a minimal role, with only Ireland reporting any need (10%), and the overall average at just 0.5%.

Table 3- Distribution of providers for skills and training needs

Training provider	Basque Country	France	Ireland	Portugal	Total
Universities	54.6%	40%	80%	92.3%	59.5%
Vocational training centres	45.5%	60%	10%	7.7%	40%
Research centres	0%	0%	0%	0%	0%
Maritime industry SMEs	0%	0%	10%	0%	0.5%

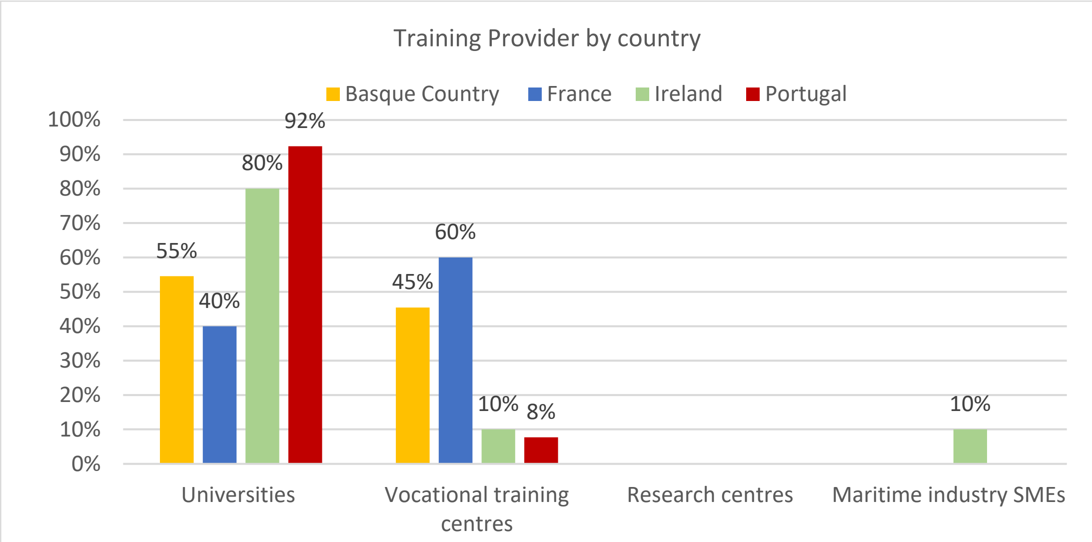

Figure 4- Distribution of providers for skills and training needs by country

2.1.4 Education Level

With an extra column for the table's overall total, Table 4 and Figure 5 offer a distribution of the target education levels, as determined by the EQF, across four regions. The five categories into which the data is divided are secondary education (EQF levels 3 and 4), post-secondary education (EQF level 5), and three levels of higher education (bachelor's at EQF 6, Master's at EQF 7, and PhD at EQF 8).

Table 4- Distribution of target education levels for skills and training needs in AA

Target Education Level	Basque Country	France	Ireland	Portugal	Total
Secondary education (EQF levels 3 & 4)	14.9%	27.3%	0%	0%	12.6%
Post-secondary (EQF level 5)	33.1%	9.1%	20%	7,7%	27.2%
High-level education (Bachelor EQF 6)	20.8%	36.4%	20%	0,0%	19.9%
High-level education (Master EQF 7)	31.2%	27.3%	50%	92,3%	39.8%
High-level education (PhD EQE 8)	0%	0%	10%	0%	0.5%

Starting with secondary education, the Basque Country and France show a notable presence, with 14.9% and 27.3% respectively, indicating that in these regions, a significant portion of the identified target education level remains at the secondary level. In contrast, both Ireland and Portugal report 0% at this level. The overall total for secondary education is 12.6%, due to the influence of the Basque Country and France.

In the post-secondary category (EQF level 5), the Basque Country stands out with 33.1%, significantly higher than France (9.1%), Ireland (20%), and Portugal (7.7%). This suggests that in the Basque

Country and Ireland, there is a strong emphasis on post-secondary, non-university qualifications. The total across all regions for this level is 27.2%, indicating that post-secondary qualifications are a substantial target in the broader context.

When examining high-level education at the bachelor's level (EQF 6), France leads with 36.4%, followed by the Basque Country and Ireland, both at 20.8% and 20% respectively, while Portugal reports 0%. The overall total is 19.9%, suggesting that, while important, bachelor's degrees are not the dominant target in most regions.

The master's level (EQF 7) shows a higher demand, particularly in Portugal, where an overwhelming 92.3% of the identified target education is at this level. Ireland also places significant emphasis here, with 50%, while the Basque Country and France have 31.2% and 27.3% respectively. The total for this level is 39.8%, making it the highest across all categories, and highlighting a strong regional and overall preference for advanced university education, especially in Portugal and Ireland, due to the nature of this partners.

Finally, at the doctoral level (PhD, EQF 8), only Ireland reports a significant figure, with 10%. The other regions and the overall total are negligible (0.5%), indicating that, while doctoral qualifications are valued in Ireland, they are not a widespread target elsewhere.

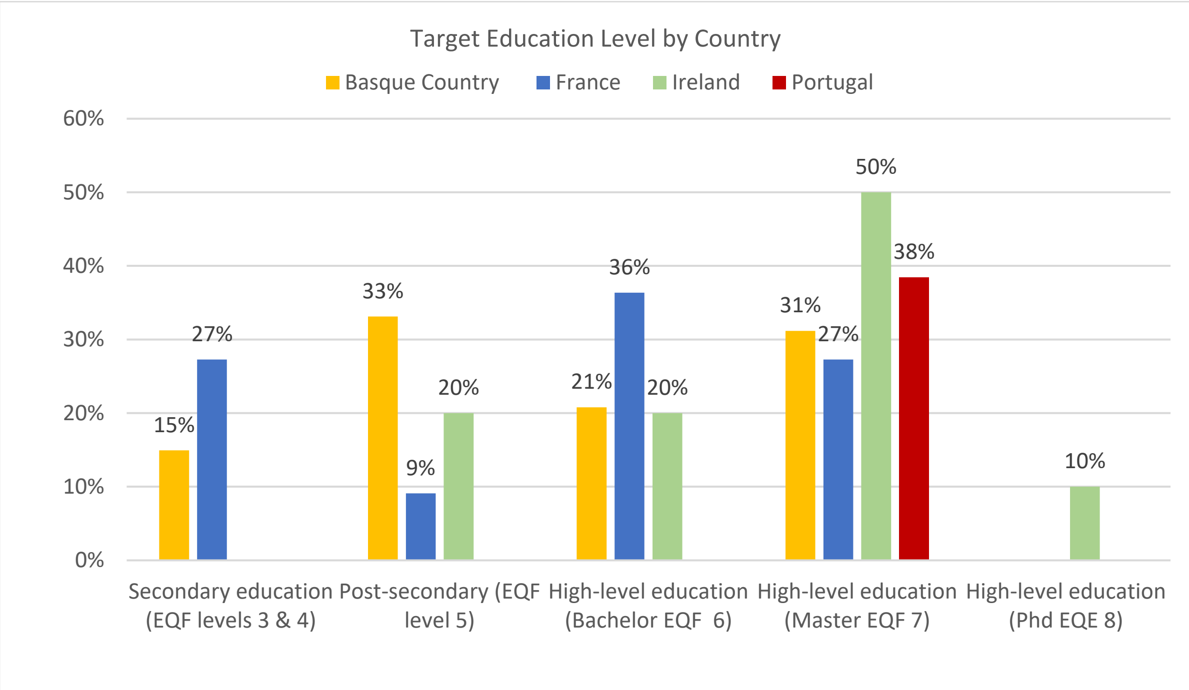

Figure 5- Distribution of target education levels for skills and training needs in the AA

In summary, both Table 4 and Figure 5 reveal notable regional differences in the target education levels. The Basque Country emphasizes post-secondary non-university qualifications, France focuses more on bachelor's degrees, Ireland and Portugal prioritize higher-level university qualifications, particularly at the master's level, and doctoral qualifications are only a significant target in Ireland. The overall trend across these regions is a clear shift towards higher education, with the master's level standing out as the most sought-after qualification.

2.1.5 Analysis of skills and training needs

Figure 6 presents a detailed overview of the maritime training needs across the EU Atlantic area. It reflects the change of the industry, marked by a growing emphasis on digital transformation, sustainability, and advanced technological systems.

At the top of the training needs spectrum, the highest demand is observed in sensor technology and data management for predictive maintenance, with 10. Closely following are artificial intelligence for predictive maintenance and decision-making, and automation systems, both with 8.

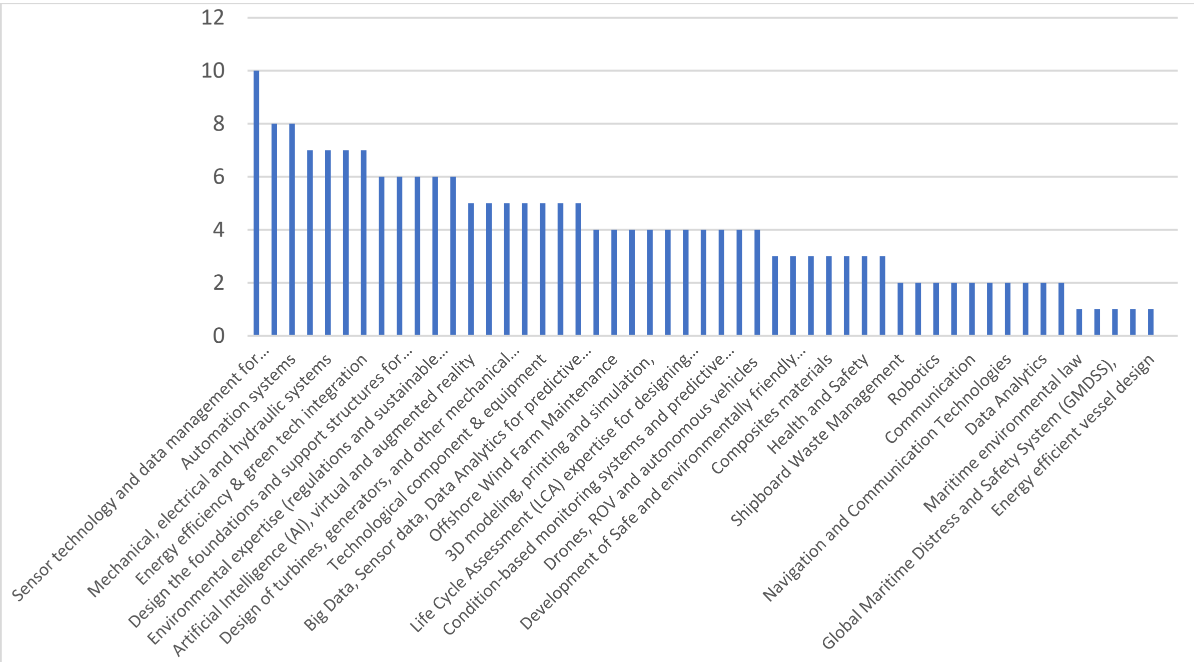

Figure 6- Ranking of skills and training needs in AA

Big data and analytics also emerge as crucial skills, particularly for fleet management and operations optimization, with 7. Other skill areas with similarly high training needs include mechanical, electrical, and hydraulic systems; subsea systems and operations; and energy efficiency coupled with green technology integration, all with 7.

Skills with moderate training needs, between 5 and 6, suggest growing importance but perhaps with less immediate urgency or wider existing skills bases. Cybersecurity expertise for secure on-board data management is one such. Similarly, skills related to the design and implementation of offshore wind farm infrastructure, electrical propulsion and control systems, and sustainable environmental as well.

Environmental assessments, integration of green technologies, and AI-based immersive technologies like virtual and augmented reality are also identified as important. Additionally, foundational skills like design of turbines, generators, and mechanical components maintain relevance.

In the lower-middle tier, skills such as operating underwater vehicles, offshore wind farm maintenance, intelligent navigation systems, 3D modelling and simulation, alternative fuels, and condition-based monitoring systems show that the industry is preparing for more specialized and technologically advanced operations.

The bottom of the table contains a long list of skills with fewer mentions, ranging from shipboard waste management and route optimization to robotics, communication, and legal expertise in maritime law. While these may not currently reflect widespread training needs across the EU Atlantic area, they could still be vital in specific contexts.

Looking broadly at the skills identified for training development in the maritime industry, these could highlight two major technological trends: the rise of smart maintenance systems and the growing focus on energy-efficient vessel and offshore design.

At the top of the list are skills such as sensor technology, data management, artificial intelligence, automation, big data analytics, and expertise in mechanical, electrical, and hydraulic systems. These skills are foundational for implementing predictive maintenance strategies, which rely on real-time monitoring, AI-driven analytics, and condition-based maintenance to reduce downtime, optimize operations, and extend asset lifespans. The integration of IoT sensors, machine learning, and big data platforms is central to this approach, enabling smarter, more proactive maintenance regimes that are increasingly becoming standard in modern fleet management and maritime operations.

Simultaneously, another cluster of high-priority skills includes energy efficiency, green technology integration, and the design of offshore wind farms and renewable energy installations. This includes expertise in designing foundations and support structures for offshore wind, electrical and propulsion systems, environmental regulations, and sustainable practices These skills are essential for the transition to low-carbon maritime operations and the expansion of offshore renewable energy, reflecting the industry's commitment to sustainability and compliance with evolving regulatory frameworks.

In conclusion, the top-ranked skills can be grouped into two broad categories: those supporting the development and deployment of smart maintenance solutions, leveraging AI, sensors, and big data for predictive maintenance, and those necessary for the design and operation of energy-efficient vessels and offshore infrastructure, including renewable energy integration and sustainable engineering practices. Both areas are critical for the maritime industry’s innovation, future competitiveness, safety, and environmental performance.

2.1.6 Roles

Figure 7 shows the distribution of roles demands in the EU Atlantic area. The analysis shows that the main roles, such as Naval Architects, Ship Operation Management, Naval Electricians, Naval Mechatronic Engineers, and Mechanical Engineers, require a broad range of skills, as evidenced by their high number of mentions (ranging from 7 to 9). These roles are at the core of the industry and must integrate multiple skills, from advanced technology and digitalization to sustainability and energy efficiency.

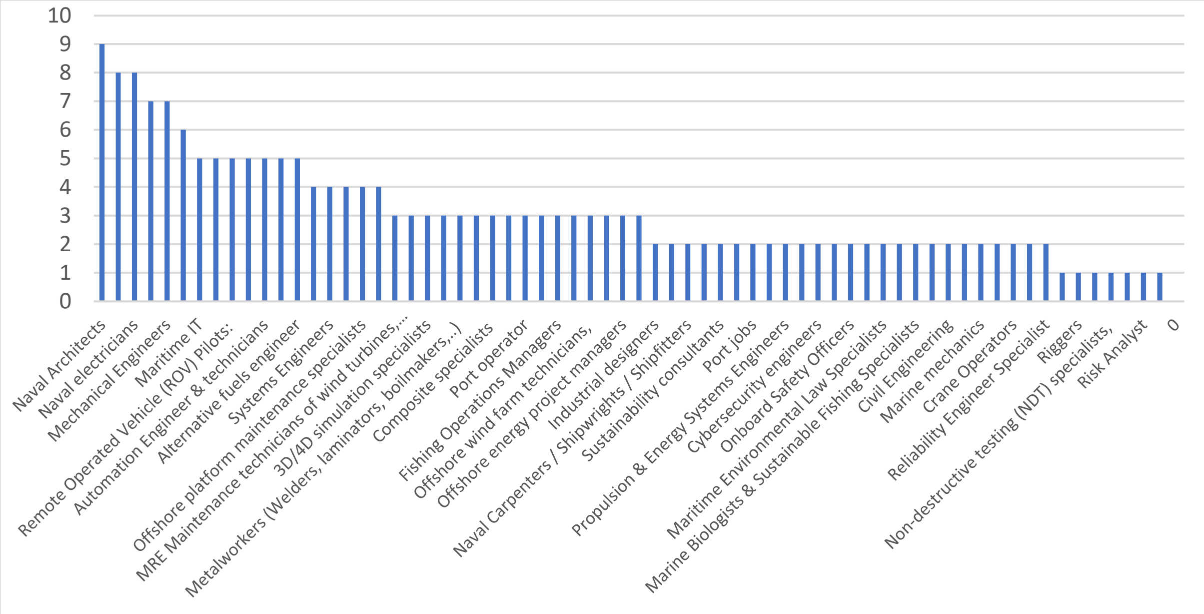

Figure 7- Ranking of roles in the AA

At the same time, there is a clear demand for specialized roles, such as ROV Pilots, AI & Smart Navigation Specialists, Automation Engineers, and Offshore Wind Farm Technicians. These positions, while mentioned less frequently, require highly specific expertise, often linked to emerging technologies or niche operations like remote vehicle operation, advanced automation, or renewable energy infrastructure.

This distribution suggests two main trends. Broad, multidisciplinary skill sets are essential for central roles involved in vessel design, operation, and management, supporting both smart maintenance (through digital, AI, and sensor integration) and efficient energy and vessel design (through engineering and sustainability knowledge).

Specialized roles are increasingly important as the industry adopts smart maintenance systems (such as ROV Pilots, AI Specialists, and Automation Engineers) and advances in energy-efficient, low-carbon vessel and offshore infrastructure design (such as Offshore Wind Farm Technicians and Alternative Fuels Engineers).

In conclusion, while the core maritime and offshore roles demand a wide array of skills to address both smart maintenance and energy efficiency, there is a growing need for specialized professionals to drive technological innovation and sustainable practices in specific areas of the industry.

2.1.7 Skill Contribution

Figure 8 shows the percentage of high-impact contributions each Blueskilling-aligned skill (Skill contribution) received. Skills related to the energy transition appear 52 times, making up 17.9% of the total, while decarbonization skills appear 43 times, accounting for 14.8%. Energy management skills are also significant, with 48 occurrences, representing 16.5% of the total. Skills related to the energy transition, decarbonization, and energy management are prominently featured, indicating a strong emphasis on green and sustainable technology. These skills are crucial for developing efficient energy systems and sustainable vessel designs.

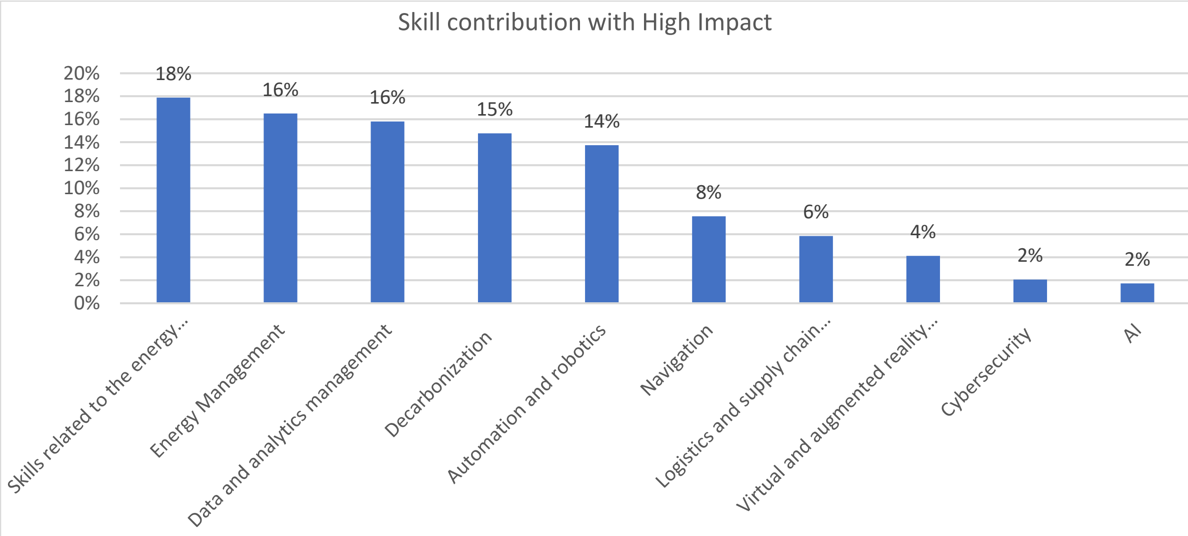

Figure 8- Distribution of skill contributions with high impact

On the other hand, skills such as data and analytics management and virtual and augmented reality skills are more aligned with digital innovation and smart maintenance. Data and analytics management is the most frequently mentioned skill in this category, appearing 46 times and making up 15.81% of the total. This skill is essential for leveraging data to drive innovation and improve maintenance processes. Virtual and augmented reality skills, although less frequent with 12 occurrences (4.12%), are also vital for creating immersive and interactive maintenance and training environments.

In summary, the figure reveals a balanced focus on both green and sustainable technology and digital innovation within the study. The high-impact skills related to energy transition, decarbonization, and energy management highlight the project's commitment to sustainability and efficient energy use. Simultaneously, the emphasis on data and analytics management and virtual and augmented reality skills demonstrates a strong push towards digital innovation and smart maintenance solutions.

2.2 Regional top skills and training needs

Upon analyzing the tables representing the most needed skills for each region, several skills emerge as common across all regions (Appendix II).

For green technology innovation, the skill needs across all regions include expertise in energy efficiency and green technology integration. This involves the design of electrical systems for power transmission and control, as well as the integration of alternative fuels such as hydrogen, ammonia, and batteries. Additionally, the design of mechanical components like turbines and generators is crucial. The use of 3D modelling, printing, and simulation technologies is also essential for creating efficient and sustainable vessel designs. Environmental expertise, including regulations and sustainable practices, is necessary to ensure that the designs are environmentally friendly. Life Cycle Assessment (LCA) expertise is important for designing vessels that are sustainable throughout their entire lifecycle. Propulsion systems, including electric, hybrid, hydrogen fuel cells, and sail-powered options, are also key components of efficient vessel design.

For digital innovation, the skill needs across all regions include sensor technology and data management for predictive maintenance. This involves the use of big data and data analytics for fleet management and operations optimization. AI is crucial for predictive maintenance and decision-making. Cybersecurity expertise is necessary for secure on-board data management. Condition-based monitoring systems and predictive maintenance strategies are also important for ensuring the longevity and reliability of vessels. Additionally, the operation of underwater vehicles, such as drones and ROVs, is essential for inspecting offshore installations and performing maintenance tasks.

In summary, the skill needs across all regions can be categorized into two main groups: efficient energy and vessel design, and smart maintenance. The former includes expertise in energy efficiency, green technology integration, mechanical and electrical design, environmental regulations, and propulsion systems. The latter includes sensor technology, data management, AI, cybersecurity, condition-based monitoring, and the operation of underwater vehicles. These skills are essential for creating sustainable and efficient vessels, as well as ensuring their reliable and long-lasting operation.

2.3 Assessment of existing training supply

2.3.1 Availability of training supply

Figure 9 and Figure 10 show that certain critical skills are in high demand but lack adequate training provision. For instance, "Artificial intelligence for predictive maintenance and decision making" is noted as the most lacking skill, with seven instances where training is unavailable. This is closely followed by skills in alternative fuels, big data for fleet management, and expertise in subsea operations, each with four gaps.

When examining roles, the main training gaps are related to AI & smart navigation specialists, ship operation management, and machine engineers. Five gaps are identified for AI & smart navigation specialists, and four for both ship operation management and machine engineers. These roles are essential for implementing the many skills that are most lacking: AI, big data, and alternative fuels, indicating a direct relationship between skill shortages and workforce needs.

The alignment between specific skills and roles is clear. AI & smart navigation specialists would require strong knowledge in artificial intelligence for predictive maintenance, intelligent navigation systems, and big data analytics. Similarly, alternative fuels engineers must be trained in alternative fuels technologies, emission control systems, and energy efficiency integration. Subsea engineers and ROV pilots need expertise in subsea systems, underwater vehicle operation, and sensor technology for predictive maintenance. The absence of training in these areas creates a bottleneck for filling these critical roles, impeding progress toward the EU's green and digital transition goals.

Given these findings, the priority for creating new training courses should focus on the intersection of digitalization and decarbonization. Courses that combine artificial intelligence, big data analytics, and alternative fuels, tailored to specific maritime roles, would address the most acute gaps. This aligns with EU strategies emphasizing blue skills, technological innovation, and sustainable competitiveness in the Atlantic region.

In summary, the most urgent training priorities are in advanced digital and green skills, specifically artificial intelligence, big data, alternative fuels, and subsea technologies. These should be developed in direct connection with the roles most in need, ensuring that training provision is both targeted and relevant to the evolving demands of the EU Atlantic maritime economy.

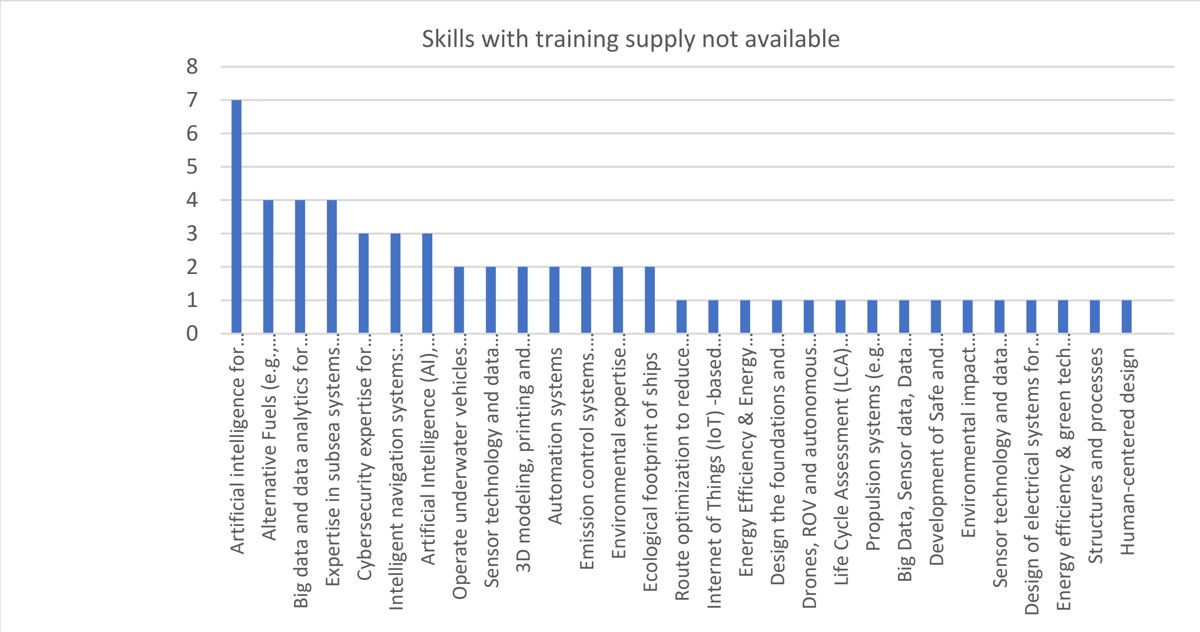

Figure 9- Ranking of skills without training in AA

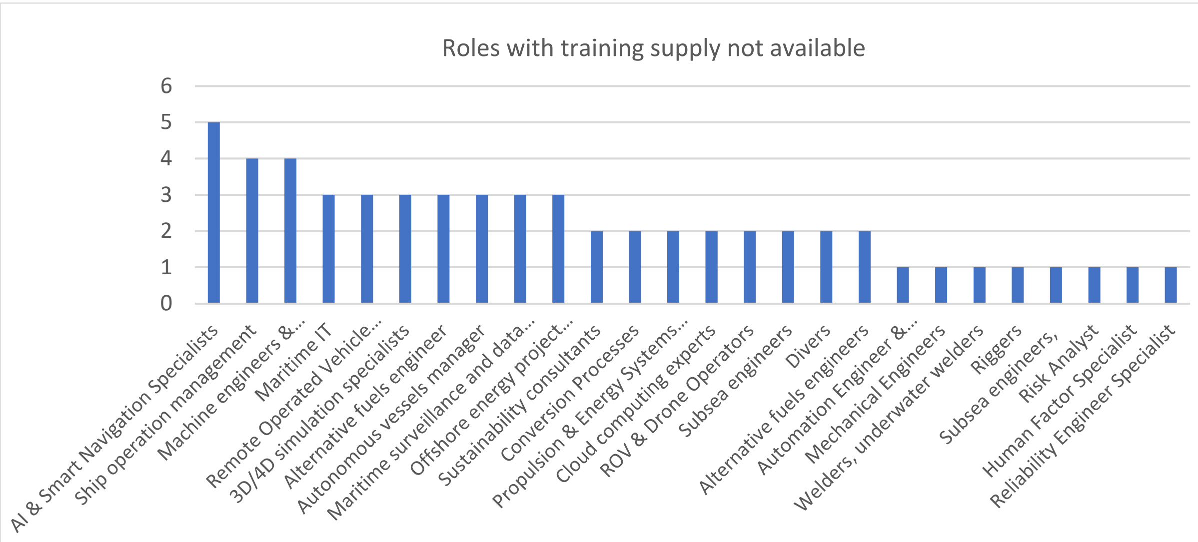

Figure 10- Ranking of roles without training in AA

Figure 11 and Figure 12 show that most critical technical and multidisciplinary skills, such as sensor technology and data management for predictive maintenance, automation systems, offshore wind farm maintenance, and the design of foundations and support structures, are rated as having the least adequate training supply, with numbers indicating persistent gaps.

This deficit is mirrored in the roles most affected, including naval mechatronic engineers, managers overseeing ecological and digital transitions, naval architects, and various maintenance and systems engineering positions. The lack of adequate training for these roles is not simply a matter of insufficient candidate numbers but reflects a lag in the content and quality of existing courses relative to rapid technological and regulatory developments.

For example, operations and maintenance roles in offshore wind are identified as having the largest skills gap, with technical expertise in areas like big data analytics, sensor integration, and predictive maintenance being especially underprovided in current training programs.

Certain skills are closely linked to specific roles. For instance, expertise in sensor technology, data management, and predictive maintenance is critical for naval mechatronic engineers, offshore wind farm technicians, and maintenance managers. Similarly, automation systems and robotics skills are directly relevant for automation engineers and systems engineers, while environmental impact assessment and sustainable practices are vital for roles such as marine biologists, sustainable fishing specialists, and maritime environmental law specialists.

Given the rapid evolution of technology in the sector, training programs must also be regularly updated to include emerging areas such as artificial intelligence, cybersecurity for on-board systems, and the integration of green technologies.

Figure 11- Skills not adequately addressed by the training supply in the AA

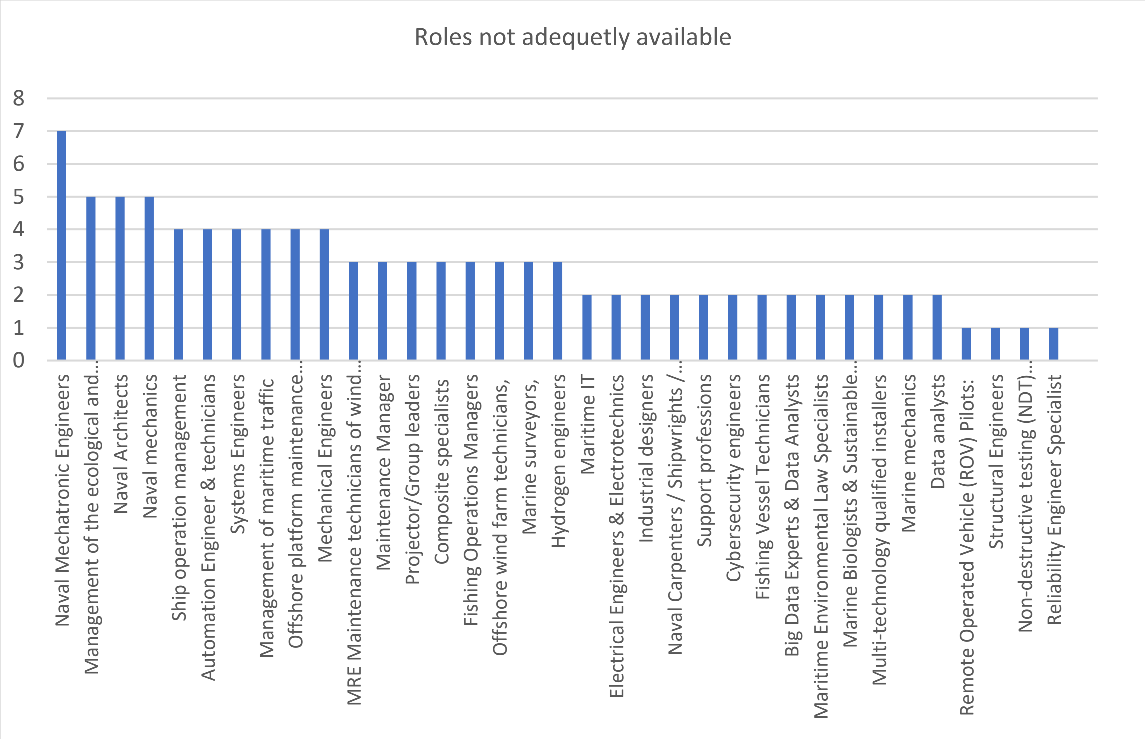

Figure 12- Roles not adequately addressed by the training supply in the AA

2.3.2 Target education providers

This section provides a comparative analysis of which skills need to be addressed by universities and which by vocational training centres. The focus here is to identify what type of education provider (academic or vocational) is most needed for specific maritime and offshore skills.

Figure 13 shows that universities are primarily responsible for providing training needs and filling training gaps with 60% compared to 40% for VET centres.

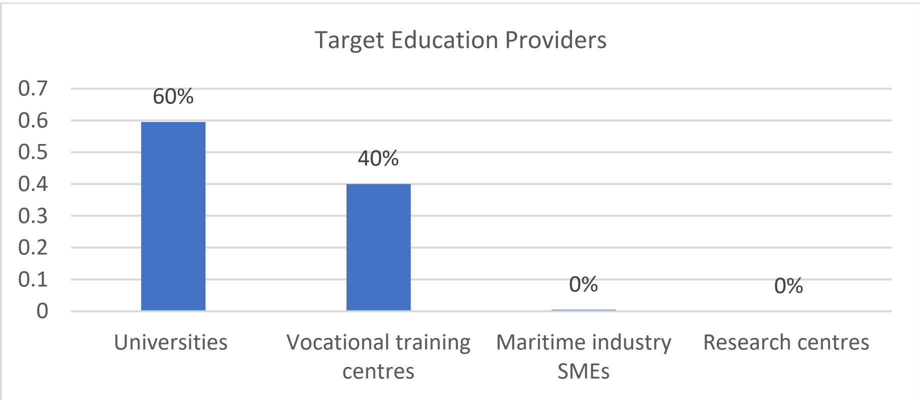

Figure 13- Distribution of training providers

Figure 14 illustrates the skills that universities need to provide. These include emerging digital technologies, system design, environmental assessment, and strategic innovation skills.

At the top of the list artificial intelligence for predictive maintenance and decision making, automation systems, and environmental expertise (each with 6) are clearly seen as university level disciplines. These fields require a strong theoretical foundation, multidisciplinary integration (such as AI and mechanical engineering), and typically demand advanced mathematics, software modelling, and system-level thinking that vocational institutions may not be equipped to deliver.

Cybersecurity (with 5) and big data applications in fleet management and predictive maintenance (also with 5) are similarly complex. These topics align more naturally with academic programs due to their heavy reliance software systems, skills typically taught in computer science, systems engineering, or naval technology programs.

Structural and design-intensive fields like designing offshore wind foundations and energy-efficient ship systems (with 5 and 4) also fall under university training. These require knowledge of fluid dynamics, material science, offshore engineering, and civil/marine architecture, areas with high liability and safety implications, often requiring accredited engineering degrees.

Notably, LCA, propulsion systems, and energy integration systems, also with between 4 and 5, highlight universities' roles in sustainability and systems-level thinking. These are newer areas in maritime that combine environmental science with mechanical, electrical, and systems engineering, disciplines typically situated in academic environments.

While many advanced topics receive a university emphasis (with 3, 4), some like shipboard waste management, composite materials, and maritime environmental law with only 2 or 1, suggesting limited but growing attention in university curricula. These might be embedded in niche specializations or electives rather than core curricula.

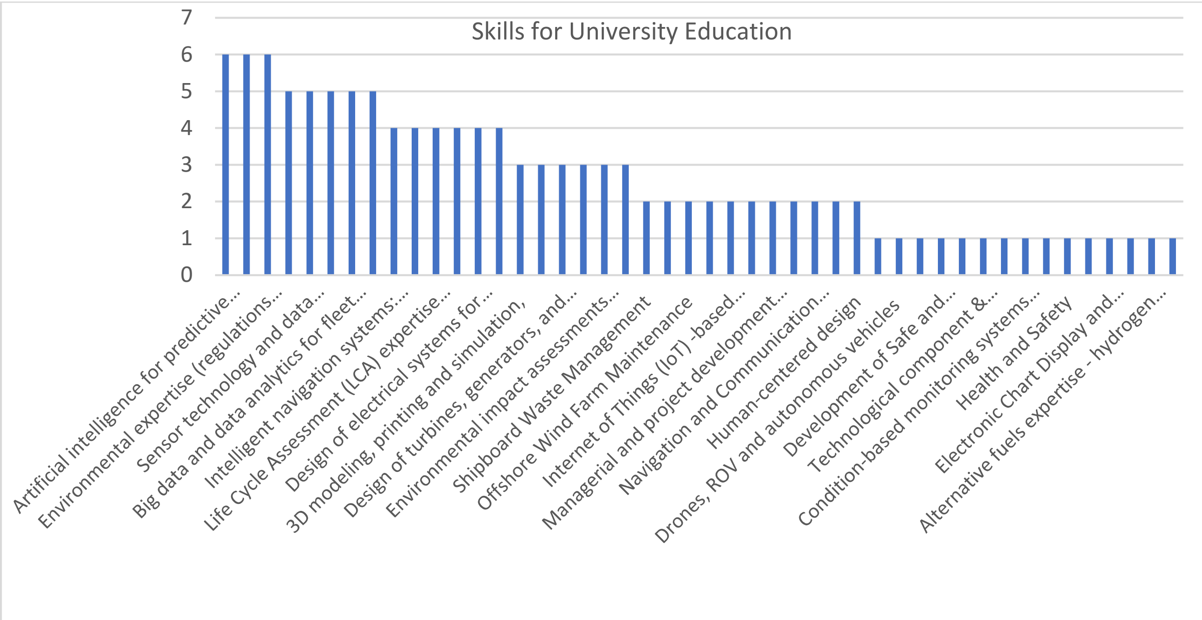

Figure 14- Distribution of skills provided by university education

In general, universities are focusing on skills that require innovation, design, regulatory understanding, strategic systems integration, and data science, all of which align with long-term, theory-heavy study tracks.

Vocational centers (Figure 15), on the other hand, are clearly focused on hands-on, application-oriented, technical, and operational skills that support day-to-day maritime activities.

On top of the list, Mechanical, electrical, and hydraulic systems with the highest at 6, reflect the core competence of vocational education. These systems are foundational to ship and offshore operations and require practical training with equipment, diagnostics, and routine maintenance.

Structures and processes and sensor technology for predictive maintenance also on top with 5, indicating that vocational centers are increasingly integrating tech-forward, semi-digital skills into their offerings. However, their focus is still on immediate operational relevance rather than advanced system design.

Further down, operation of underwater vehicles, electrical control systems, condition-based maintenance, and drones/ROVs (with 3 and 4) show that vocational institutions are expanding into emerging but practical technologies. These skills are essential for offshore inspections, remote maintenance, and fleet automation, but at the operational, not design, level.

However, many critical emerging or hybrid skills, like AI for predictive maintenance (with only 2), big data, alternative fuels, and environmental impact analysis, are underrepresented in vocational training.

At the bottom of the list, AI/VR, IoT, robotics, LCA, emission control systems, and other environmentally or digitally complex areas are found. These are domains where vocational centers either lack the expertise, infrastructure, or curriculum development necessary to train workers adequately.

Interestingly, core safety and compliance topics such as health and safety, environment also are at the bottom, suggesting either a lack of integrated training or that these are managed by specialized training entities (e.g., IMO-certified centers) outside of general vocational schools.

The analysis confirms a clear division of educational labor: universities dominate in strategic, analytical, and design-oriented skills, while vocational centers cover tactical, operational, and hands-on implementation skills.

This concludes some key needs:

Curriculum bridging: Emerging technical roles demand hybrid profiles (e.g., technicians who understand predictive data models or engineers who grasp on-site constraints). Educational systems must foster modular and stackable credentials that allow vertical movement from vocational to academic pathways. Academic programs must include practical learning (labs, simulators, internships) to ensure employability.

Digital infrastructure: Both systems need to invest in areas like emissions technology, lifecycle analysis, robotics, and alternative propulsion, skills crucial to EU green transition goals.

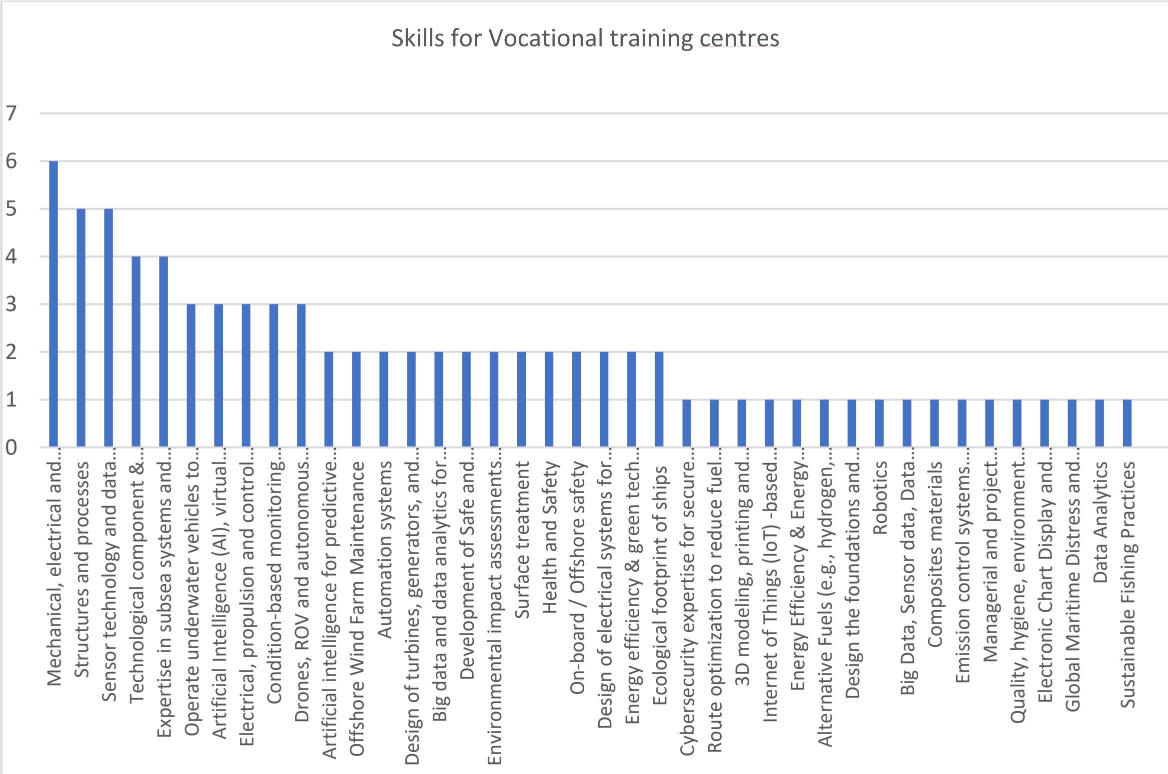

Figure 15- Distribution of skills provided by vocational training

Figure 16 and Figure 17 illustrate the educational requirements for a range of roles in the maritime and offshore sectors by categorizing with university-level education or VET. The comparative results reflect the ideal training responsibility for each role. This makes it possible to evaluate the appropriate level of formal education needed for workforce development in these fields.

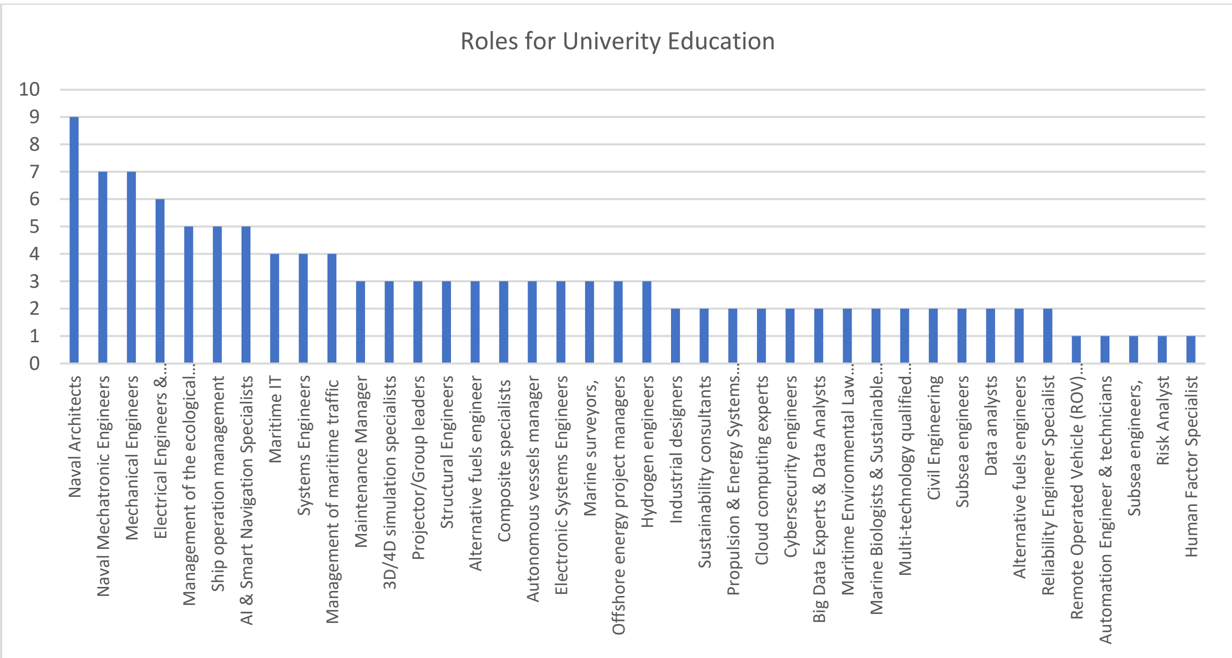

Figure 16- Distribution of roles for university education

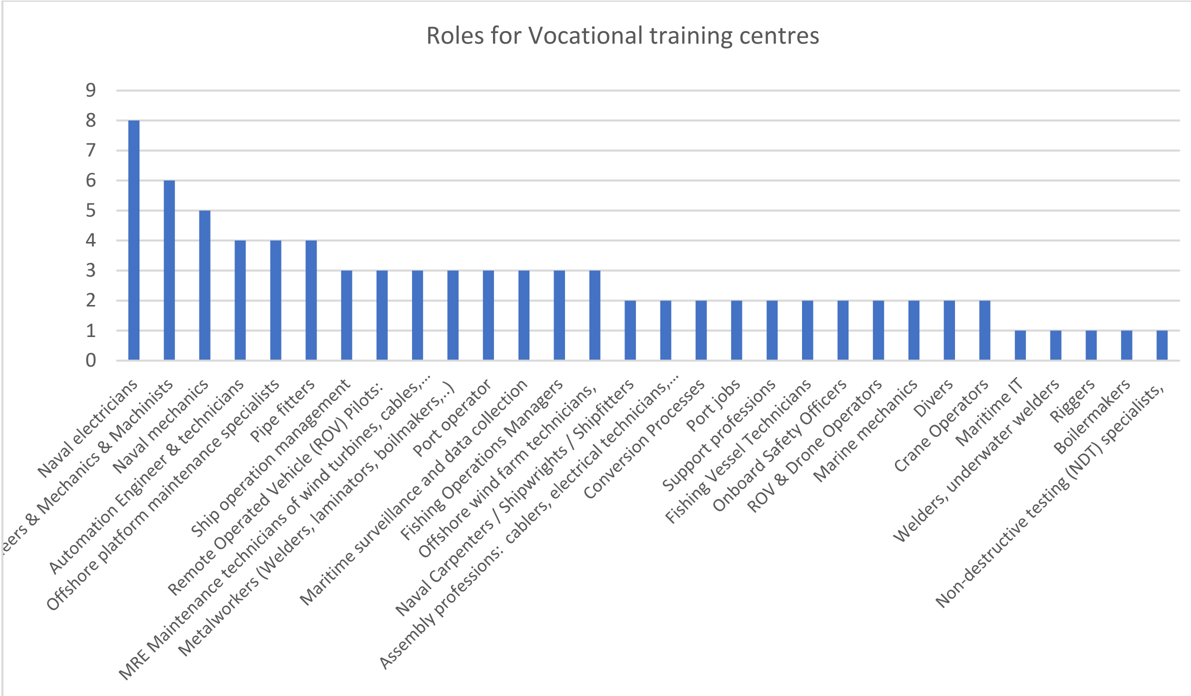

Figure 17- Distribution of roles for vocational training centers

Starting with roles that demand university-level education, Naval Architects (9) are the most strongly associated with higher education. This makes sense, as they are responsible for the design and structural integrity of ships and marine structures, requiring advanced knowledge of fluid dynamics, structural engineering, and maritime regulations—skills taught in accredited engineering or naval architecture degree programs.

Similarly, Naval Mechatronic Engineers and Mechanical Engineers (7) belong to high-skill, theory-driven professions that require multidisciplinary training in systems integration, mechanical design, and electronic control systems. These roles cannot be sufficiently developed at the VET level, as they demand deep theoretical understanding and proficiency in software tools (e.g. CAD or CFD), and systems diagnostics.

Electrical Engineers, Electrotechnics, Systems Engineers, and Structural Engineers (between 4 and 6) also require university degrees. Their responsibilities often extend beyond maintenance or operation and include system design, installation planning, and compliance with safety and environmental standards. These engineers work across high-voltage systems, automation, and infrastructure, and often must be certified by engineering bodies or maritime authorities.

Roles like AI & Smart Navigation Specialists, Cybersecurity Engineers, Big Data Experts, and Cloud Computing Experts (with 2 to 5) are digitally intensive and emerging roles. While some elements of digital training may be introduced at the VET level, the complexity of these domains, including algorithm development, machine learning, data analytics, and secure architecture design, demands university-level education, typically in computer science, software engineering, or marine informatics.

Marine surveyors, Alternative Fuels Engineers, Sustainability Consultants, Hydrogen Engineers, and Offshore Energy Project Managers (with 2 and 3) are roles situated in specialized or regulatory contexts. These professionals require not only technical expertise but also a grounding in environmental law, energy systems, and lifecycle analysis, fields covered in postgraduate or interdisciplinary academic programs.

Furthermore, university training is also essential for leadership and strategic roles like Projectors/Group Leaders, Maintenance Managers, Management of Ecological and Digital Transition, and Management of Maritime Traffic. These positions often combine technical oversight with managerial duties and thus benefit from academic programs that include economics, systems thinking, or policy and governance modules.

On the vocational side, the data confirms that Naval Electricians, Machine Engineers, Mechanics, and Naval Mechanics are core VET roles. From 5 to 8, these roles require hands-on skills in diagnostics, repairs, and equipment handling, all of which are best taught through apprenticeships, workshops, and real-life simulation environments that VET centers specialize in.

Automation Technicians, Port Operators, Pipe Fitters, Welders, and Metalworkers (with 3 and 4) are also firmly vocational. These are critical operational roles requiring technical proficiency, precision, and safety awareness, but not the abstract or analytical skills associated with university-level education. Their focus is on reliable execution, rather than design or system integration.

ROV Pilots, ROV & Drone Operators, and Offshore Platform Maintenance Specialists sit somewhat in between (2 and 3). These roles are increasingly technical and require specialized training on remote systems and robotics. They can be trained effectively within high-level VET programs that include simulator use, safety certification, and supervised fieldwork.

Similarly, roles like Fishing Operations Managers, Onboard Safety Officers, Diving Specialists, Marine Mechanics, and Assembly Technicians are all practical in nature. While some may benefit from complementary academic training (e.g., in marine biology or sustainability), the core skillset is operational and rooted in physical execution, aligning them with vocational training models.

Some roles with niche specialization, such as Crane Operators, Riggers, and Boilermakers are very clearly VET roles. These involve highly technical, narrowly focused skills that are best learned through certification and practical experience, rather than academic programs.

In summary, university education is essential for design, systems integration, emerging technologies, engineering leadership, and sustainability-focused roles, while vocational education is best suited to hands-on, operational, and equipment-based roles. A few hybrid roles could span both domains, indicating the need for more modular, flexible training pathways that allow VET-trained professionals to transition into more advanced roles with additional certification or academic upskilling. As the maritime sector evolves with digitalization and decarbonization, addressing these educational gaps and overlaps will be critical for building a resilient and competent workforce.

2.4 Potential training course

A comprehensive analysis of current and future industry skill requirements lacking training supply was conducted. This analysis involved identifying and logically grouping relevant skills based on how they support industry functions and understanding the relationships between these skills to guide effective curriculum development.

2.4.1 Grouping of top skills needs & gaps (AA)

Table 5 lists the main skills needs & gaps in the Atlantic Area. After evaluating all skills, a grouping approach was applied (Table 6), combining those within the same area of expertise, which could potentially be taught together.

Two primary groups were established: Energy efficiency/Efficient ship design and operation (green); Maintenance-related skills (orange). Additional minor groups were also identified: Autonomous/Automation/Intelligent navigation systems (yellow); (Artificial Intelligence (AI), virtual and augmented reality/3D modelling, printing and simulation) (purple); and, notably present across all regions, Cybersecurity (light blue).

Table 5- Main skills needs and gaps in AA

Top Skills needs & Gaps
Sensor technology and data management for predictive maintenance
Artificial intelligence for predictive maintenance and decision making
Automation systems
Big data and data analytics for fleet management and operations optimization
Mechanical, electrical and hydraulic systems
Expertise in subsea systems and operations
Energy efficiency & green tech integration
Cybersecurity expertise for secure on-board data management
Design the foundations and support structures for offshore wind farms and other renewable energy installations
Electrical, propulsion and control systems
Environmental expertise (regulations and sustainable practices)
Design of electrical systems for power transmission and control
Artificial Intelligence (AI), virtual and augmented reality
Energy Efficiency & Energy Management System / Integration of green technologies
Design of turbines, generators, and other mechanical components
Environmental impact assessments and mitigation strategies
Technological component & equipment
Structures and processes
Big Data, Sensor data, Data Analytics for predictive maintenance
Operate underwater vehicles to inspect offshore installations

Offshore Wind Farm Maintenance
Intelligent navigation systems: autonomy of ships, sensors, navigation instruments, dynamic positioning, electronics...
3D modelling, printing and simulation
Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps...)
Life Cycle Assessment (LCA) expertise for designing sustainable vessels
Propulsion systems (e.g. electric, hybrid, hydrogen fuel cells, sail-powered)
Condition-based monitoring systems and predictive maintenance strategies
Ecological footprint of ships
Drones, ROV and autonomous vehicles

Table 6- Main skill groups

Main groups
Energy efficiency/Efficient ship design and operation
Maintenance related skills
Autonomous/Automation/Intelligent navigation systems
Digital visualization skills
Cybersecurity

As a result of this analysis, two main thematic groups of skills are established "**Intelligent maintenance of ships and offshore systems**" and "**Smart and sustainable ship design and operation**". These two groups provide a structured foundation for the development of an industry-aligned training program. Together, they represent a holistic framework that not only addresses current skills gaps but also anticipates future workforce needs in the maritime and offshore domains. This structure offers a strategic starting point for building targeted and flexible training pathways to upskill professionals and support sustainable industry growth.

The skills in the thematic group of Intelligent maintenance of ships and offshore systems are presented in Table 7. This group covers 33% of all skill gaps identified.

Table 7- Skills for Intelligent maintenance of ships and offshore systems

Main Group 1: Intelligent maintenance of ships and offshore systems
Condition-based monitoring systems and predictive maintenance strategies
Sensor technology and data management for predictive maintenance.
Artificial intelligence for predictive maintenance and decision making
Big Data, Sensor data, Data Analytics for predictive maintenance
Data Analytics
Cybersecurity expertise for secure on-board data management
Internet of Things (IoT) -based solutions
Mechanical, electrical and hydraulic systems

Electrical, propulsion and control systems
Design of electrical systems for power transmission and control
Technological component & equipment
Propulsion systems (e.g. electric, hybrid, hydrogen fuel cells, sail-powered)
Expertise in subsea systems and operations,
Operate underwater vehicles to inspect offshore installations
Offshore Wind Farm Maintenance
Artificial Intelligence (AI), virtual and augmented reality
Health and Safety

The skills in the thematic group of Smart and efficient ship design and operation are presented in Table 8. This group covers 41% of all skill gaps identified.

Table 8- Smart and efficient ship design and operation

Main Group 2: Smart and efficient ship design and operation
Energy efficiency & green tech integration
Energy-efficient vessel design
Energy Efficiency & Energy Management Systems (EEMS) / Integration of green technologies
Maritime environmental law
Environmental expertise (regulations and sustainable practices)
Life Cycle Assessment (LCA) expertise for designing sustainable vessels
Ecological footprint of ships
Environmental impact assessments and mitigation strategies
Development of Safe and environmentally friendly decommissioning techniques.
Propulsion systems (e.g electric, hybrid, hydrogen fuel cells, sail-powered)
Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps...)
Emission control systems. (propulsion, battery storage, reducing emissions)
Electrical, propulsion and control systems
Design of electrical systems for power transmission and control
Route optimization to reduce fuel consumption and emissions.
Big data and data analytics for fleet management and operations optimization

2.4.2 Programme Structure (Modules & Skills) of Potential Training Courses

As illustrative examples and potential candidates for full courses, for each group, preliminary course syllabi have been developed. Each syllabus is organized into modules, thus dividing the groups into focused subgroups that reflect the aspects of the field.

Intelligent Maintenance of Ships and Offshore Systems

Programme Objective:

To develop multidisciplinary expertise in intelligent maintenance strategies, technologies, and operations for ships and offshore systems, enhancing performance, reliability, and sustainability.

Programme Structure (Modules & Skills)

Module 1: Smart Maintenance and Predictive Technologies

Objective: Learn to implement predictive maintenance using AI, sensors, and data analytics.

- Condition-based monitoring systems and predictive maintenance strategies
- Sensor technology and data management for predictive maintenance
- Artificial intelligence for predictive maintenance and decision making
- Big Data, Sensor data, Data Analytics for predictive maintenance
- Data Analytics
- Cybersecurity expertise for secure on-board data management
- Internet of Things (IoT)-based solutions

This module captures the convergence of smart technologies enabling predictive maintenance and operational efficiency. As vessels become increasingly sensor-driven and data-rich, skills in data analytics, IoT integration, and AI decision systems are vital. However, there's a lag in formal training around data governance, cybersecurity, and the real-time analytics needed for shipboard systems.

Module 2: Maritime and Offshore System Technologies

Objective: Gain technical skills in marine systems and emerging propulsion technologies.

- Mechanical, electrical and hydraulic systems
- Electrical, propulsion and control systems
- Design of electrical systems for power transmission and control
- Technological component & equipment
- Propulsion systems (e.g., electric, hybrid, hydrogen fuel cells, sail-powered)

This group focuses on the core technical systems that drive ship performance and energy use. As new propulsion options emerge, engineers must master both legacy and cutting-edge technologies. Yet many training programs still focus heavily on conventional systems, underpreparing students for integrating electric or hybrid propulsion, or the controls and electrical architectures that support them.

Module 3: Marine & Subsea Operations - Offshore Renewable Systems

Objective: Develop capabilities in subsea inspection and offshore wind maintenance.

- Expertise in subsea systems and operations
- Operate underwater vehicles to inspect offshore installations
- Offshore Wind Farm Maintenance
- Artificial Intelligence (AI), virtual and augmented reality

Skills in this cluster are critical for offshore energy and infrastructure development, particularly as marine renewables (like wind) expand. Expertise in subsea operations and autonomous inspection vehicles is essential, but currently, training in offshore environments and remote operations remains niche and often learned only through field experience. It emphasizes emerging digital tools and the human factors in their design and application with AI and VR/AR. Health and safety knowledge remains foundational in deploying such innovations responsibly.

Smart & Sustainable Ship Design and Operation (Energy Efficient Ship Design and Operation)

Programme Objective:

Equip professionals with interdisciplinary skills for designing, managing, and operating ships that are environmentally sustainable, energy-efficient, and digitally advanced.

Programme Structure (Modules & Skills)

Module 1: Foundations of Sustainable Maritime Practices

Objective: Introduce environmental frameworks, regulations, and design principles.

- Maritime environmental law
- Environmental expertise (regulations and sustainable practices)
- Energy efficiency & green tech integration
- Energy-efficient vessel design
- Energy Efficiency & Energy Management Systems (EEMS) / Integration of green technologies

Environmental performance is both a regulatory and market demand. Skills here are crucial for compliance and cost reduction. However, few marine engineers are deeply trained in environmental law or integrated green systems, often learned only on-the-job or through postgrad study.

Module 2: Environmental Assessment and Lifecycle Thinking

Objective: Provide tools to assess, quantify, and minimize environmental impacts over a ship's lifecycle.

- Life Cycle Assessment (LCA) for sustainable vessels
- Ecological footprint of ships
- Environmental impact assessments and mitigation strategies
- Safe and environmentally friendly decommissioning techniques

These skills are central to vessel lifecycle thinking—how ships are designed, operated, and retired sustainably. LCA and decommissioning are very underrepresented in current curricula, despite their growing importance under IMO decarbonization goals.

Module 3: Clean Propulsion and Energy Systems

Objective: Explore sustainable alternatives to traditional marine propulsion and power systems.

- Propulsion systems: electric, hybrid, hydrogen fuel cells, sail-powered
- Alternative fuels: hydrogen, ammonia, batteries, etc.

- Emission control systems (propulsion, battery storage, reducing emissions)
- Electrical, propulsion and control systems
- Design of electrical systems for power transmission and control

This cluster focuses on designing and maintaining the next generation of clean propulsion. There is a notable training lag in fuels like hydrogen/ammonia and battery systems, skills now essential due to industry transition pressures.

Module 4: Digital Maritime Operations and Optimization

Objective: Leverage data and intelligent technologies to optimize ship performance.

- Route optimization to reduce fuel consumption and emissions
- Big data and analytics for fleet management and operational optimization
- Cybersecurity for secure on-board data management
- Intelligent navigation systems: autonomy, sensors, navigation instruments, dynamic positioning
- Automation systems

This module emphasizes the integration of data-driven technologies and intelligent systems to optimize vessel operations. Covering route optimization, big data analytics, cybersecurity, autonomous navigation, it fills the gap between traditional maritime operations and modern digital transformation.

Module 5: Innovation, AI and Human-Centered Design

Objective: Foster user-centric design and emerging technologies for future-ready vessels.

- Human-centered design
- Artificial Intelligence (AI), virtual and augmented reality
- Innovation strategies for maritime digital transformation

This module's strategic impact includes enhanced safety, efficiency, and sustainability through human-centered automation and advanced control systems with AI and VAR, paving the way for the future of smart, autonomous shipping.

3. A MULTI-CRITERIA DECISION AIDING PROBLEM TO PRIORITISE SKILLS AND TRAINING GAPS AND NEEDS

Strategic planning processes demand a structured and transparent approach to decision-making. Multi-Criteria Decision Aiding (MCDA) provides a powerful framework for addressing such challenges. It supports decision-makers by enabling the systematic evaluation of diverse options against a set of predefined criteria, thereby improving the rationality, consistency, and justifiability of the choices made.

MCDA methods are designed to decompose complex decisions into manageable components. These typically include the identification of relevant criteria, the creation of workable alternatives, the weighting of criteria to reflect their relative importance, the evaluation of alternatives against those criteria, and the aggregation of results to produce a ranked list of preferred options. This structured approach allows for a more comprehensive understanding of the trade-offs involved in decision-making and facilitates stakeholder engagement by making the process more transparent.

This chapter introduces the theoretical foundations and practical applications of MCDA within the context of the Blueskilling project, an initiative focused on strategic training investment and workforce transformation. Specifically, it explores the use of the Deck of Cards Method (DCM) to build a complete MCDA model for assessing new training alternatives and ranking them in a prioritized list.

3.1 Deck of Cards Method (DCM)

3.1.1 Theoretical Overview

This subchapter provides a theoretical overview of the DCM, a robust tool in MCDA. Originating from Figueira et al. (2002) and later revised by Corrente et al. (2021). DCM facilitates the assessment of criterion weights. It translates different criteria scales into a common interval, accounting for preference and allowing for flexible scale ranges. The subchapter explores DCM's concepts, applications, and its integration with comparison tables, offering an understanding of its role in decision analysis.

DCM is distinguished by its use of preference cards to express the magnitude of difference between ranked items. For example, for a risk classification of ships' profiles, in (Dinis et al., 2023), various factors like ship age, flag performance, and accident history were weighted based on expert assessments of level preferences.

3.1.2 Application Procedure

The DCM involves the following steps:

1. **Criteria and Alternatives Definition:** Identify the full set of evaluation criteria

$$G = \{g1, \dots, g_n\}$$

and alternatives (in this case results from partners)

$$A = \{a_1, \dots, a_n\}.$$

2. **Level Identification:** For each criterion g_j, define a scale $E_j = \{l_{j,1}, \dots, l_{j,k}\}$ reflecting ordered levels, $l_{j,k}$ represents a single level of a criterion.

3. **Card Input:** Rank and order from worst to best the levels and use metaphorical cards placed between them to express the intensity of preference differences, the more the bigger the preference.

$$l_1 < e_{1,2} < l_2 < e_{2,\dots} < \dots < e_{\dots,k} < l_k$$

   $e_{n,p}$ represents the number of cards after level n and before level p.

4. **Matrix Construction:** Create a comparison table necessary for next step

Table 9- Comparison table

	l_1	l_2	$\dots$	l_k
l_1		$e_{1,2}$	$e_{1,2} + e_{2,\dots} + 1$	$e_{1,2} + e_{2,\dots} + 1 + e_{2,\dots}$ $+ e_{\dots,k} + 1 + 1$
l_2			$e_{2,\dots}$	$e_{2,\dots} + e_{\dots,k} + 1$
$\dots$				$e_{\dots,k}$
l_k				

Start by filling the table with the cards inserted between two consecutive levels determined previously. And following a consistency condition, fill the rest of the table where, for any three levels n, p, and q with n < p < q, the following must hold:

$$e_{np} + e_{pq} + 1 = e_{nq}$$

5. **Level Values:** Calculate the value of each level of the criteria using the total number of cards between levels. The level value is computed as:

$$v_{j(l_{j,k})} = v_{j(l_{j,t})} + (e_{t,k} + 1) \cdot \alpha$$

   Where

$$\alpha = \frac{v_j(l_{j,t}) - v_j(l_{(j,1)})}{e+1}$$

   and $e_{(t,k)}$ is the cumulative card count between levels.

5. **Criteria Weighting with Dummy Alternatives:** Construct hypothetical alternatives that score 100 in one criterion and 1 in all others, making n alternatives to n criteria. Rank these dummy alternatives using DCM again to determine criteria importance.

6. **Z-Ratio Indifference Comparison:** Establish a Z-ratio to balance the influence between highest and lowest ranked criteria and calculate the minimum unit value:

$$\alpha = \frac{Z \cdot w_l - w_l}{e_{1,n} + 1}$$

   Where w_l is the weight of the least important criterion.

7. **Normalization:** Normalize the weights of each criterion:

$$\overline{w}_j = \frac{w_j}{\sum_{j=1}^{n} w_j}$$

8. **Final Aggregation:** Evaluate each alternative using the weighted sum:

$$v(a_i) = \sum_{j=1}^{n} \overline{w}_j \left(\sum_{k=1}^{n} w(l_{j,k}) \right)$$

3.2 Methodology. Prioritization of skills and training gaps and needs

The methodology for prioritization of skills and training gaps and needs consists of 4 main steps:

1) Structuring the problem, that includes defining the objective and specifying criteria and sub-criteria: relevant to decision-maker;
2) Define the set of alternatives/actions to be assessed corresponding to the set of skills needs & gaps identified in the WP3 Excel spreadsheet: "WP3_A - List of skills and training gaps and needs";
3) Assess the performance of the alternatives/actions on the criteria and sub-criteria;
4) Sorting of alternatives/actions according to their performance values on the weighted criteria using the DCM.

3.2.1 Structuring the problem

The objective is to rank a set of skills needs & gaps requiring the development/adaptation of training curricula.

The main criteria correspond to the skill assessment criteria specified in WP3 Excel spreadsheet: "WP3_A - List of skills and training gaps and needs":

- g_1: **Challenge Impact** - The extent to which addressing the skill will impact specific challenges.
- g_2: **Skill Contribution** - The primary skill areas the training will impact.
- g_3: **Target Education Level** - The education level the training is aimed at.
- g_4: **Target Training Providers** - The organizations or individuals who should deliver the training.
- g_5: **Type of Training** – The format or method of the training.
- g_6: **Training Duration** - The length of the training program.

The sub-criteria for all criteria are also derived from the regional skills needs and gaps identified in the Excel spreadsheet. Table 10 shows the sub-criteria for each criterion. Note that these were the options to select for each criterion in the WP3 Excel spreadsheet: "WP3_A".

3.2.2 Alternatives to be assessed

Chapter 4's responses, from the "WP3_A – List of skills and training gaps and needs" spreadsheet, are the alternatives that are evaluated in this analysis. These alternatives are all the skills with a lack of training that were identified across the four European regions in the Atlantic area to promote the development of green and digital technologies for blue innovation.

Table 10- Criteria and sub-criteria

g_1 : Challenge Impact	g_2 : Skill contribution
$I_{1,1}$ Digitalization	$I_{2,1}$ Cybersecurity
$I_{1,2}$ Innovation	$I_{2,2}$ Virtual and augmented reality skills
$I_{1,3}$ Energy transition	$I_{2,3}$ Data and analytics management
$I_{1,4}$ Maritime decarbonization	$I_{2,4}$ Automation and robotics
	$I_{2,5}$ Skills related to the energy transition
	$I_{2,6}$ Decarbonization
	$I_{2,7}$ Logistics and supply chain management
	$I_{2,8}$ Navigation
	$I_{2,9}$ Energy management
	$I_{2,10}$ AI
g_3 : Target education level	**g_4: Target Education/training providers**
$I_{3,1}$ Secondary education (EQF levels 3 & 4)	$I_{4,1}$ Universities
$I_{3,2}$ Post-secondary (EQF level 5)	$I_{4,2}$ Vocational training centers
$I_{3,3}$ High-level education (Bachelor EQF 6)	$I_{4,3}$ Research centers
$I_{3,4}$ High-level education (Master EQF 7)	$I_{4,4}$ Maritime industry SMEs
$I_{3,5}$ High-level education (PhD EQE 8)	
g_5 : Types of Training	**g_6 : Training Duration**
$I_{5,1}$ Initial	$I_{6,1}$ 4 years
$I_{5,2}$ Continuing	$I_{6,2}$ 3 years
$I_{5,3}$ Apprenticeship	$I_{6,3}$ 2 years
$I_{5,4}$ Initial & apprenticeship	$I_{6,4}$ 1 year
$I_{5,6}$ Regulatory	$I_{6,5}$ 180-1000h
	$I_{6,6}$ 40-180h
	$I_{6,7}$ <40h

3.2.3 Sub-criteria value functions

After specifying the sub-criteria, the next step is to calculate its value function to calculate the performance of each alternative on the criteria and sub-criteria.

First, it is necessary to rank the order of the sub-criteria for each criterion. This order is determined by the data in the spreadsheet, specifically by the frequency of mentions, the higher the number, the higher the ranking. References for both maximum and minimum values are provided, with 100 and 1 respectively. The number of cards between sub-criteria is calculated as the difference in the number of mentions, in the data, between each pair of adjacent sub-criteria. This approach enables the creation of a comparison table to calculate the value of a unit (α) and thus the values of the sub-criteria, ultimately yielding the value function. A table with the normalized values is also obtained at the end.

It is important to note that these calculated levels are purely data-driven. Typically, this process would involve ranking the order of importance according to a decision-maker's preferences. However, in this study, it was assumed that the number of mentions could directly imply the order of importance.

So, for the first criterion g_1 the responses are ordered by number of mentions of only high and low impact, excluding thus no impact (Table 11).

Table 11- Results and subsequent order of the sub-criteria of g_1

	Challenge Impact	Mentions
$l_{1,2}$	Innovation	204
$l_{1,1}$	Digital	182
$l_{1,4}$	Maritime decarbonization	171
$l_{1,3}$	Energy transition	163

Thus, giving the order of preference is presented as:

$$l_{1,3} < l_{1,4} < l_{1,1} < l_{1,2}$$

Table 12 shows the comparison table created for the criterion g1 with the cards added between two consecutive sub-criteria levels identified in bold.

Table 12- Comparison table for g_1

	Energy transition	Maritime decarbonization	Digital	Innovation
Energy transition		**8**	20	43
Maritime decarbonization			**11**	34
Digital				**22**
Innovation				

The minimum unit of difference is calculated as:

$$\alpha = \frac{v(l_{1,2}) - v(l_{1,3})}{43 + 1} = 2.25$$

Figure 18 shows the resulting value function of g1' sub-criteria. The normalised weights of g1' sub-criteria, $w(l_{1,k})$ are given in Table 13.

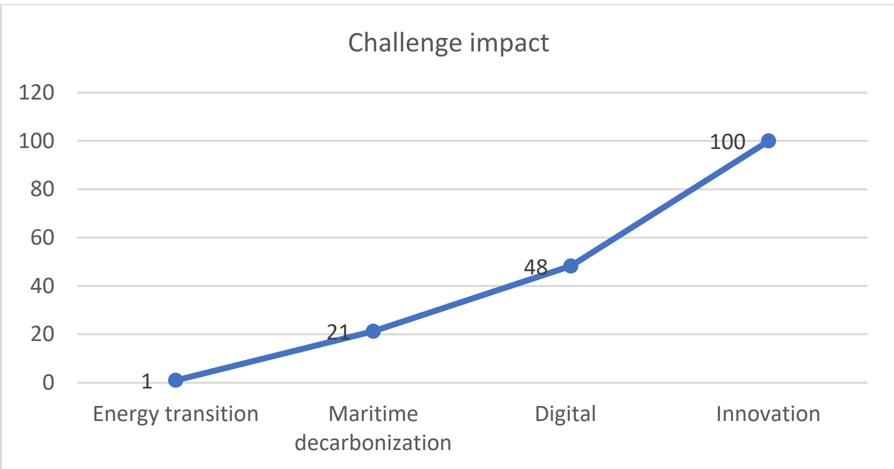

Figure 18- Value function of g ' sub-criteria, $v(l_{1,k})$

Table 13- Normalized weights of g_1 ' sub-criteria, $w(l_{1,k})$

Challenge Impact	Normalized weights
Innovation	0.59
Digital	0.28
Maritime decarbonization	0.12
Energy transition	0.01

Table 14 presents the ranking of the sub-criteria of second criterion g_2 using the method previously explained.

Table 14- Results and subsequent order of the sub-criteria of g_2

	Skill Contribution	Mentions
$l_{2,5}$	Skills related to the energy transition	76
$l_{2,9}$	Energy Management	71
$l_{2,3}$	Data and analytics management	60
$l_{2,6}$	Decarbonization	54
$l_{2,4}$	Automation and robotics	48
$l_{2,8}$	Navigation	32
$l_{2,7}$	Logistics and supply chain management	21
$l_{2,2}$	Virtual and augmented reality skills	19
$l_{2,1}$	Cybersecurity	12
$l_{2,10}$	AI	5

The preferences of the sub-criteria are sorted as follows:

$$l_{2,10} < l_{2,1} < l_{2,2} < l_{2,7} < l_{2,8} < l_{2,4} < l_{2,6} < l_{2,3} < l_{2,9} < l_{2,5}$$

Table 15 shows the comparison table for criterion g_2 with added cards represented in bold.

Table 15- Comparison table for criterion g_2

	AI	Cybersecurity	Virtual and augmented reality skills	Logistics and supply chain management	Navigation	Automation and robotics	Decarbonization	Data and analytics management	Energy Management	Skills related to the energy transition
AI		**7**	15	18	30	47	54	61	73	79
Cybersecurity			**7**	10	22	39	46	53	65	71
Virtual and augmented reality skills				**2**	14	31	38	45	57	63
Logistics and supply chain management					**11**	28	35	42	54	60
Navigation						**16**	23	30	42	48
Automation and robotics							**6**	13	25	31
Decarbonization								**6**	18	24
Data and analytics management									**11**	17
Energy Management										**5**
Skills related to the energy transition										

α is calculated as:

$$\alpha = \frac{v(l_{2,5}) - v(l_{2,10})}{79+1} = 1.24$$

Figure 19 shows the resulting value function of criterion g2 and its normalized values are provided in Table 16.

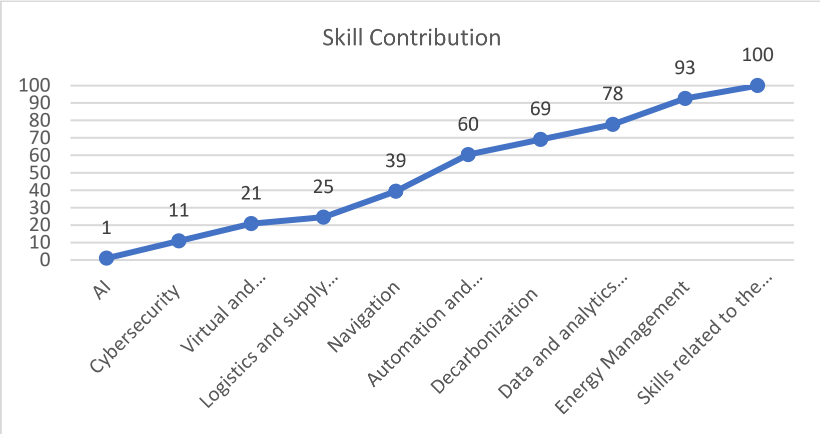

Figure 19-Value function of g_2' sub-criteria, $v(l_{2,k})$

Table 16- Normalized weights of g_2' sub-criteria, $w(l_{2,k})$

Sub-criteria	Normalized weights
Skills related to the energy transition	0.20
Energy Management	0.19
Data and analytics management	0.16
Decarbonization	0.14
Automation and robotics	0.12
Navigation	0.08
Logistics and supply chain management	0.05
Virtual and augmented reality skills	0.04
Cybersecurity	0.02
AI	0.00

Repeating the process for the remaining criteria g_3, g_4, g_5 and g_6 the sub-criteria orders are obtained (Table 17,Table 18, Table 19 and Table 20).

Table 17- Results and subsequent order of the sub-criteria of g_3

	Target education level	Mentions
$l_{3,4}$	High-level education (Master EQF 7)	82
$l_{3,2}$	Post-secondary (EQF level 5)	56
$l_{3,3}$	High-level education (Bachelor EQF 6)	41
$l_{3,1}$	Secondary education (EQF levels 3 & 4)	26
$l_{3,5}$	High-level education (PhD EQE 8)	1

Table 18- Results and subsequent order of the sub-criteria of g_4

	Target Education/training providers	Mentions
$l_{4,1}$	Universities	122
$l_{4,2}$	Vocational training centres	82
$l_{4,4}$	Maritime industry SMEs	1
$l_{4,3}$	Research centres	0

Table 19- Results and subsequent order of the sub-criteria of g_5

	Types of Training	Mentions
$l_{5,2}$	Continuing	88
$l_{5,1}$	Initial	87
$l_{5,4}$	Initial & apprenticeship	27
$l_{5,3}$	Apprenticeship	3
$l_{5,6}$	Regulatory	0

Table 20- Results and subsequent order of the sub-criteria of g_6

	Training Duration	Mentions
$l_{6,3}$	2 years	99
$l_{6,4}$	1 year	48
$l_{6,1}$	4 years	37
$l_{6,6}$	40 - 180 h	9
$l_{6,5}$	180-1000 h	5
$l_{6,2}$	3 years	3
$l_{6,7}$	<40h	0

The comparison tables of the criteria g_3, g_4, g_5 and g_6 are represented in Table 21, Table 22, Table 23 and Table 24.

Table 21- Comparison table for g_3

	High-level education (PhD EQE 8)	Secondary education (EQF levels 3 & 4)	High-level education (Bachelor EQF 6)	Post-secondary (EQF level 5)	High-level education (Master EQF 7)
High-level education (PhD EQE 8)		**25**	41	57	84
Secondary education (EQF levels 3 & 4)			**15**	31	58
High-level education (Bachelor EQF 6)				**15**	42
Post-secondary (EQF level 5)					**26**
High-level education (Master EQF 7)					

Table 22- Comparison table for g_4

	Universities	Vocational training centres	Maritime industry SMEs	Research centres
Research centres		**1**	83	124
Maritime industry SMEs			**81**	122
Vocational training centres				**40**
Universities				

Table 23- Comparison table for g_5

	Regulatory	Apprenticeship	Inital & apprenticeship	Initial	Continuing
Regulatory		**3**	28	89	91
Apprenticeship			**24**	85	87
Inital & apprenticeship				**60**	62
Initial					**1**
Continuing					

Table 24- Comparison table for g_6

	<40h	3 years	180-1000 h	40 - 180 h	4 years	1 year	2 years
<40h		**0**	1	3	6	9	11
3 years			**0**	2	5	8	10
180-1000 h				**1**	4	7	9
40 - 180 h					**2**	5	7
4 years						**2**	4
1 year							**1**
2 years							

The value functions of criteria g_3, g_4, g_5 and g_6 are shown in *Figure 20*, *Figure 21*, *Figure 22* and *Figure 23*.

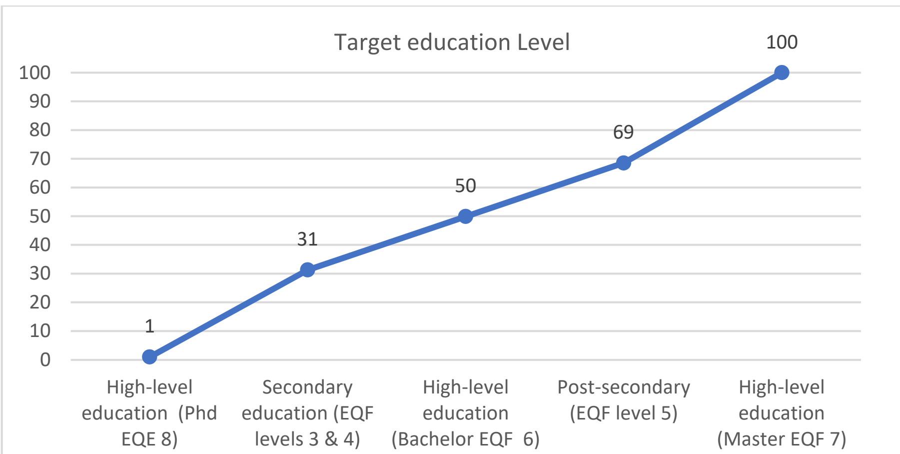

Figure 20- Value function of g_3' sub-criteria, $v(l_{3,k})$

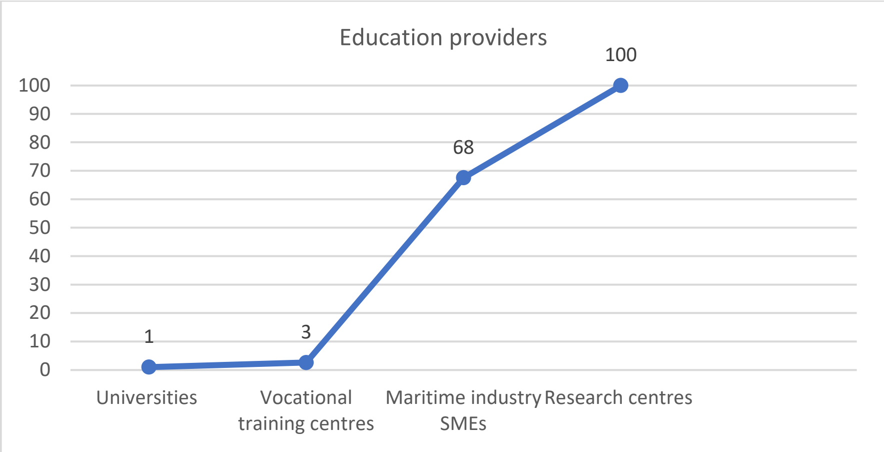

Figure 21- Value function of g4' sub-criteria, $v(l_{4,k})$

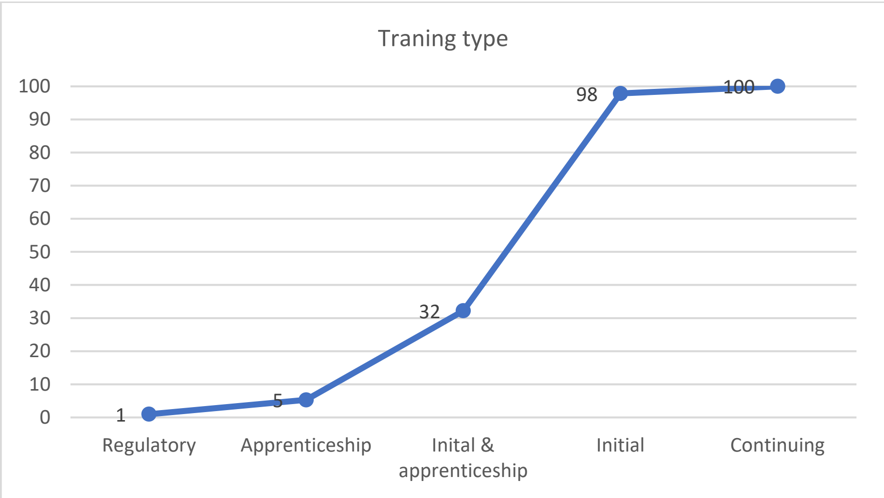

Figure 22- Value function of g5' sub-criteria, $v(l_{5,k})$

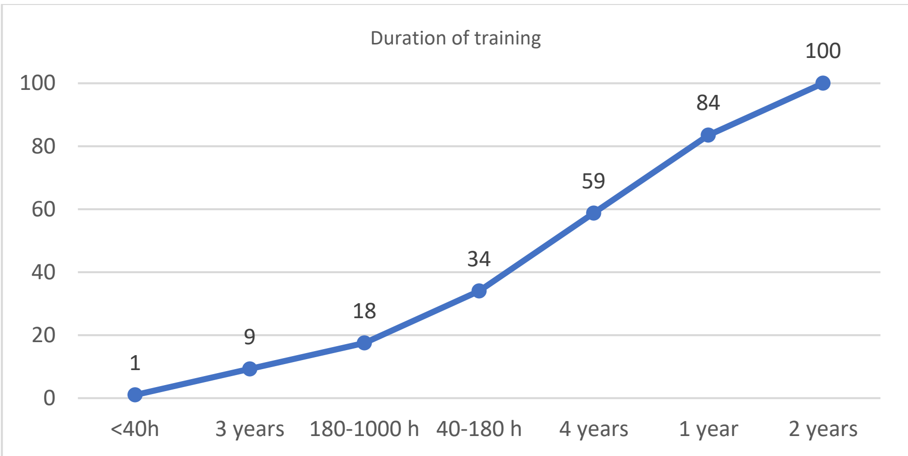

Figure 23- Value function of g6' sub-criteria, $v(l_{6,k})$

Finally, the normalized values are presented in Table 25, Table 26, Table 27 and Table 28.

Table 25- Normalized weights of the values of g_3 sub-criteria, $w(l_{3,k})$

Sub-criteria	Normalized weights
High-level education (Master EQF 7)	0.40
Post-secondary (EQF level 5)	0.27
High-level education (Bachelor EQF 6)	0.20
Secondary education (EQF levels 3 & 4)	0.12
High-level education (PhD EQE 8)	0.00

Table 26- Normalized weights of the values of g_4 sub-criteria, $w(l_{4,k})$

Sub-criteria	Normalized weights
Universities	0.58
Vocational training centres	0.39
Maritime industry SMEs	0.02
Research centres	0.01

Table 27- Normalized weights of the values of g_5 sub-criteria, $w(l_{5,k})$

Sub-criteria	Normalized weights
Continuing	0.42
Initial	0.41
Initial & apprenticeship	0.14
Apprenticeship	0.02
Regulatory	0.00

Table 28- Normalized weights of the values of g_6 sub-criteria, $w(l_{6,k})$

Sub-criteria	Normalized weights
2 years	0.33
1 year	0.27
4 years	0.19
40 - 180 h	0.11
180-1000 h	0.06
3 years	0.03
<40h	0.00

3.2.4 Criteria Weighting

The criteria weights are calculated in more than one way in this work. Since the preferences of the decision makers have a major impact, several scenarios are formulated.

Before presenting the different scenarios, a brief explanation of the final score evalatuion must be presented. The final score is calculated by an aggregation model, with the two first criteria having a slightly different calculation.

The first criterion (Challenge Impact) has 4 sub-criteria each one assessed as high impact, low impact and no impact. To differentiate these alternatives an extra weight is added to the value level giving 100% for high impact 30% for low impact and 0 for no impact. This approach allows to account for the importance of the challenge impact and the sub-criterion levels.

For the second criterion (Skill Contribution), the number of relevant sub-criteria vary. To always have a possibility to have the best and the worst option, a heuristic approach is adopted in which the weight is calculated depending on the number of skills mentioned. So, if only one skill is mentioned, then its weight is directly multiplied by the criteria weight, if not, the sum of the chosen skills (2,3 or 4) sub-criteria's weights is compared and normalized to the sum of the maximum weight of the best ranked sub-criteria (group by 2, 3 or 4 correspondingly).

The three scenarios formulated to prioritize skills and training gaps and needs are the following:

- The first scenario assumes same weights to all criteria, thus the final scores are entirely data driven through the sub-criteria weights previously calculated.
- The second scenario reflects the priorities of the Blueskilling project.
- The final scenario considers the industry's priorities.

The criteria weights follow a two reference values, for the worst and the best values of the scale (Table 29).

Table 29- Performance levels and values

Criterion	g_1	g_2	g_3	g_4	g_5	g_6
Preferable direction	max	max	max	max	max	Max
g_j^r	none	none	none	none	none	None
g_j^s	high	high	high	high	high	high
$v_j(g_j^r)$	0	0	0	0	0	0
$v_j(g_j^s)$	100	100	100	100	100	100

3.3 Scenario 1: Same weight criteria

This scenario assumes that all criteria are equally important and gives no preference to any one of them. This gives the sub-criteria weights, which are the only way to distinguish results, a much greater influence. These findings are solely based on the data gathered about the training from Chapter 3 along with the data from other European Atlantic areas. The order chosen was the following (Table 30):

Table 30- Order of criteria from best to worst according to the data results

Criteria
Challenge impact
Skill Contribution
Target education level
Training providers
Type of Training
Training Duration

Since no preference is given, no cards are added, and the comparison table is calculated as shown in Table 31.

Table 31- Criteria comparison table for scenario 1

	Training Duration	Type of Training	Training providers	Target education	Challenge impact	Skill Contribution
Training Duration		**0**	1	2	3	4
Type of Training			**0**	1	2	3
Training providers				**0**	1	2
Target education level					**0**	1
Challenge impact						**0**
Skill Contribution						

For the **z** ratio, the comparation between the worst and best criteria in this case is the same so $z = 1$ and so the calculation of $\alpha = 0$.

Table 32 shows the normalized weights of the criteria for scenario 1.

Table 32- Normalized weights of criteria for scenario 1

Criteria	Normalized weights
Training Duration	0.17
Type of Training	0.17
Training providers	0.17
Target education level	0.17
Challenge impact	0.17
Skill Contribution	0.17

3.4 Scenario 2: Blueskilling objectives

In this scenario the priorities reflect the Blueskilling project's objective that is focused on the innovation of digital and sustainable technologies and the creation of new training course through its partners. For these reasons the decision maker would value more the Skill Contribution and Challenge Impact as well as the characteristics of the training to be provided (Table 33).

Table 33- Order of criteria from best to worst for scenario 2

Criteria
Skill Contribution
Challenge impact
Target education level
Training providers
Type of Training
Training Duration

The main focus here is the skill contribution, the challenge impact and the target education level, aligned with the goals of a good educational framework for the development and innovation of green and digital technologies, thus having a higher importance than the rest of the criteria.

Using the DCM and adding cards, given the importance chosen, the comparison Table 34 shows the results for this scenario:

Table 34- Criteria comparison table for scenario 2

	Training Duration	Type of Training	Training providers	Target education level	Challenge impact	Skill Contribution
Training Duration		2	4	10	14	17
Type of Training			1	7	11	14
Training providers				5	9	12
Target education level					3	6
Challenge impact						2
Skill Contribution						

By comparing the best weight of the worst criterion with the worst weight of the best criterion so that they have the same order of importance, this is, an indifferent relationship, the **z** ratio is obtained.

Let be, an alternative, a_1, which scores the lowest on all criteria except for the least preferred (Training Duration, g_6), and an alternative, a_2, which scores the lowest for all criteria except for the most important (Skills Contribution, g_2). By lowering the level of the g_2 for the a_2 until its preference is equal to a_1, an indifference between alternatives a_1 and a_2 is achieved.

$$a_1 = (1,1,1,1,1,100) \qquad a_2 = (1, x, 1,1,1,1)$$

In this case, the lowest sub-criteria in criterion g_2 considered to achieve an indifference is Navigation, $v_2(l_{2,8}) = 39.36$, so the z ratio, α, the criteria weights and their normalization are calculated (Table 35).

$$a_1 = (1,1,1,1,1,100) \sim a_2 = (1,39.36,1,1,1,1)$$

$$z = \frac{w_6}{w_2} = 2.54$$

$$\alpha = \frac{z * w_6 - w_6}{17 + 1}$$

Table 35- Non-normalized and normalized weights for criteria in scenario 2

Criteria	Non normalized weight	Normalized weight
Training Duration	1.00	0.10
Type of Training	1.26	0.12
Training providers	1.43	0.14
Target education level	1.94	0.19
Challenge impact	2.28	0.22
Skill Contribution	2.54	0.24

3.5 Scenario 3: Industry needs

In this scenario, the priorities are slightly different, by giving preference to the industry needs.

Table 36 shows the defined criteria preference order.

Table 36- Order of criteria from best to worst for scenario 3

Criteria
Skill Contribution
Target education level
Training providers
Type of Training
Training Duration
Challenge impact

Table 37 represents the criteria comparison table for scenario 3 obtained through the DCM.

Table 37- Criteria comparison table for scenario 3

	Challenge impact	Training Duration	Type of Training	Training providers	Target education	Skill Contribution
Challenge impact		**1**	4	5	13	16
Training Duration			**2**	3	11	14
Type of Training				**0**	8	11
Training providers					**7**	10
Target education level						**2**
Skill Contribution						

The **z** ratio and α, are calculated using the same method from the 2nd scenario by assuming two alternatives a_1 and a_2. For this scenario the worst ranked criterion is Challenge Impact, in a_1, while the best is Skill Contribution, in a_2. The sub-criterion of a_2 considered to be of equal preference to the best of a_1 is Virtual and augmented reality skills.

$$v_2(l_{2,2}) = 20.8$$

$$a_1 = (100,1,1,1,1,1) \sim a_2 = (1,20.8,1,1,1,1)$$

$$\frac{w_1}{w_2} = 4.81$$

$$\alpha = \frac{z * w_1 - w_1}{16 + 1}$$

Table 38 shows the normalized weights of the criteria for scenario 3.

Table 38- Non-normalized and normalized weights for criteria in scenario 3

Criteria	Non normalized weight	Normalized weight
Challenge impact	1.00	0.06
Training Duration	1.45	0.09
Type of Training	2.12	0.13
Training providers	2.34	0.15
Target education level	4.14	0.26
Skill Contribution	4.81	0.30

3.6 Results and analysis

Finally, after applying the DCM to obtain the sub-criteria level values and the weights of the criteria, it is possible to calculate the final performance scores of all considered alternatives using the aggregation model.

3.6.1 Results of the first scenario

For the first scenario, a data-based input is used for the weighting of the sub-criteria. The main results are presented in Table 39.

This scenario appears to prioritize skills closely related to green technology and energy transition. Three alternatives with green technology skills achieved the highest performance scores, each reaching 97.3 points. These alternatives also aligned well with the type of training needed, scoring highly across most educational criteria. Overall, all nine alternatives scored above 94 points.

3.6.2 Results of the second scenario

In the second scenario, the decision-maker applied the DCM from the perspective of the Blueskilling project's objectives, emphasizing not only specific skills for industrial innovation but also the type of educational providers involved.

As shown in Table 40, the top-performing alternatives are again associated with green and energy technologies. The results are similar to those in the first scenario, though the highest score here is slightly higher, reaching 98.4 points.

3.6.3 Results of the third scenario

In the third scenario, the evaluation reflects the industry perspective, which shifts some of the priorities. Using the previously described method, the performance results are presented in Table 41.

While sustainability and energy transition skills continue to dominate, one alternative focuses on offshore maintenance has also a high score (96.2 points), a difference from the previous scenarios. In this case, the top 10 alternatives score above 96, making this scenario the one with the highest overall scores

Table 39- Best performing alternatives for scenario 1

Sector	Skill	Service	Role	Challenge impact (17)	Skill Contribution (17)	Target education level	Training providers	Type of Training	Training Duration	score
Shipbuilding	Energy Efficiency & Energy Management System / Integration of green technologies	Shipbuilding project manager	Projector/Group leaders	16.7	16.7	100	100	100	83.5	97.3
Shipbuilding	Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps,..)	Propulsion & Energy Systems Development	Alternative fuels engineer	13.4	16.7	100	100	100	83.5	94
Shipbuilding	Energy Efficiency & Energy Management System / Integration of green technologies	Propulsion & Energy Systems Development	Propulsion & Energy Systems Engineers	16.7	16.7	100	100	100	83.5	97.3
Offshore energy	Energy efficiency & green tech integration	Development of digital solutions	Data analysts	16.7	16.7	100	100	100	83.5	97.3
Offshore energy	Design the foundations and support structures for offshore wind farms and other renewable energy installations	Management of offshore renewable energy projects	Offshore energy project managers	13.4	16.7	100	100	100	83.5	94
Offshore energy	Energy efficiency & green tech integration	Management of offshore renewable energy projects	Offshore energy project managers	13.4	16.7	100	100	100	83.5	94
Offshore energy	Design of turbines, generators, and other mechanical components	Development of digital solutions	Hydrogen engineers	16.7	16.7	100	100	100	83.5	97.3
Offshore energy	Alternative fuels expertise - hydrogen production, storage and transportation	Development of digital solutions	Hydrogen engineers	16.7	16.7	100	100	100	83.5	97.3
Shipbuilding	Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps,..)	Maritime Technologies & Engineering	Alternative fuels engineer	12	16.1	100	100	100	100	94.7

Table 40- Best performing alternatives for scenario 2

Sector	Skill	Service	Role	Challenge impact (22)	Skill Contribution (24)	Target education level	Training providers	Type of Training	Training Duration	score
Shipbuilding	Energy Efficiency & Energy Management System / Integration of green technologies	Shipbuilding project manager	Projector/Group leaders	22	24.3	100	100	100	83.5	98.4
Shipbuilding	Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps,..)	Propulsion & Energy Systems Development	Alternative fuels engineer	17.5	24.3	100	100	100	83.5	94.1
Shipbuilding	Energy Efficiency & Energy Management System / Integration of green technologies	Propulsion & Energy Systems Development	Propulsion & Energy Systems Engineers	22	24.3	100	100	100	83.5	98.4
Offshore energy	Energy efficiency & green tech integration	Development of digital solutions	Data analysts	22	24.3	100	100	100	83.5	98.4
Offshore energy	Design the foundations and support structures for offshore wind farms and other renewable energy installations	Management of offshore renewable energy projects	Offshore energy project managers	17.5	24.3	100	100	100	83.5	94.1
Offshore energy	Energy efficiency & green tech integration	Management of offshore renewable energy projects	Offshore energy project managers	17.5	24.3	100	100	100	83.5	94.1
Offshore energy	Design of turbines, generators, and other mechanical components	Development of digital solutions	Hydrogen engineers	22	24.3	100	100	100	83.5	98.4
Offshore energy	Alternative fuels expertise - hydrogen production, storage and transportation	Development of digital solutions	Hydrogen engineers	22	24.3	100	100	100	83.5	98.4
Shipbuilding	Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps,..)	Maritime Technologies & Engineering	Alternative fuels engineer	15.7	23.5	100	100	100	100	93

Table 41- Best performing alternatives for scenario 3

Sector	Skill	Service	Role	Challenge impact (6)	Skill Contribution (30)	Target education level	Training providers	Type of Training	Training Duration	score
Shipbuilding	Energy Efficiency & Energy Management System / Integration of green technologies	Shipbuilding project manager	Projector/Group leaders	6.3	30.3	100	100	100	83.5	98.5
Shipbuilding	Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps,..)	Propulsion & Energy Systems Development	Alternative fuels engineer	5.1	30.38	100	100	100	83.5	97.2
Shipbuilding	Energy Efficiency & Energy Management System / Integration of green technologies	Propulsion & Energy Systems Development	Propulsion & Energy Systems Engineers	6.3	30.38	100	100	100	83.5	98.5
Offshore energy	Energy efficiency & green tech integration	Development of digital solutions	Data analysts	6.3	30.3	100	100	100	83.5	98.5
Offshore energy	Design the foundations and support structures for offshore wind farms and other renewable energy installations	Management of offshore renewable energy projects	Offshore energy project managers	5.1	30.38	100	100	100	83.5	97.2
Offshore energy	Energy efficiency & green tech integration	Management of offshore renewable energy projects	Offshore energy project managers	5.1	30.3	100	100	100	83.5	97.2
Offshore energy	Design of turbines, generators, and other mechanical components	Development of digital solutions	Hydrogen engineers	6.3	30.3	100	100	100	83.5	98.5
Offshore energy	Alternative fuels expertise - hydrogen production, storage and transportation	Development of digital solutions	Hydrogen engineers	6.3	30.3	100	100	100	83.5	98.5
Shipbuilding	Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps,..)	Maritime Technologies & Engineering	Alternative fuels engineer	4.5	29.3	100	100	100	100	97.2
Offshore energy	Offshore Wind Farm Maintenance	Operations & Maintenance & Repair	Maintenance Manager	2.5	30.3	100	100	100	100	96.2

3.6.4 Analysis of the results

The analysis of the three scenarios exemplifies how different weighting and prioritization approaches in the decision-making model, DCM, can influence the results on the training needs in maritime and offshore sectors.

The results of the three scenarios analyzed through the Deck of Cards Model in the MCDA application demonstrate a high degree of consistency across the top-performing skills, despite the variation in the weights assigned to criteria in each scenario. This outcome is attributed to the fact that the sub-criteria levels—such as target education level, training providers, type of training, and training duration—remain constant throughout all three scenarios. As a result, these constant values exert a stabilizing influence on the overall scoring, leading to minimal variation among the rankings.

Across all three scenarios, the highest scoring options consistently involve skills related to **Energy Efficiency & Energy Management System / Integration of green technologies, Alternative Fuels engineering, and Digital solutions for energy efficiency**. Notably, roles such as propulsion systems engineers, project managers in shipbuilding, and data analysts in offshore energy consistently receive top scores, regardless of the weighting emphasis on criteria like challenge impact or skill contribution. This suggests that the prioritization of these specific skill sets remains robust under different strategic outlooks, making them a "safe bet" for workforce development and investment. The highest scoring skill across all scenarios is consistently associated with the integration of green technologies and hydrogen solutions, signaling a clear convergence around these competencies.

However, the apparent stability in results may conceal details that could be discovered with more variation in the weighting of the sub-criteria. If the sub-criteria of criteria such as training duration or training type were adjusted according to the focus of each scenario, the model might yield more differentiated and context-sensitive rankings. For instance, in a scenario prioritizing immediate impact, the industry, shorter training durations might carry more weight, potentially reshuffling the top alternatives. Therefore, to enhance the model's sensitivity and realism, future applications should consider aligning sub-criteria weights with the scenario objectives.

Finally, these prioritized skills and roles align well with the goals of the European Green Deal, which emphasizes sustainability, energy transition, and digitalization. The focus on hydrogen technologies, alternative fuels, and energy efficiency underscores the importance of upskilling for the green transition. These results provide evidence-based direction to concentrate training resources on these areas, ensuring workforce readiness for future economy.

4. CONCLUSIONS

This report has demonstrated that there are significant opportunities in the EU's AA to strengthen its blue economy through alignment with the ongoing green and digital transitions. These transitions, driven by the principles of Industry 4.0, present a crucial moment for the maritime sector to renew its approach to workforce development. As the maritime industry evolves toward smarter, more sustainable practices, a systemic update of the training and education supply is urgently needed to ensure the development of the right skills to support future competitiveness.

Skills related to the integration of green technologies are critical for driving innovation. Despite the existence of various training programs and courses across both university and vocational levels, many of these offerings are outdated and misaligned with current and future industry demands. The analysis of existing training supply revealed a gap between available education and the actual skills needed by industry in areas such as digitalization, alternative fuels, and energy efficiency. Training programs that cover these topics can help professionals develop the expertise needed to integrate these technologies into industrial processes.

Digital skills are essential for supporting green technology innovation. Training programs that focus on data analytics, digital solutions, and Industry 4.0 technologies can equip professionals with the tools needed to leverage data-driven solutions and optimize industrial processes. This can lead to improved efficiency, reduced waste, and enhanced sustainability.

Through the identification of skill needs and training gaps, two major priority areas for training development are proposed: **"Intelligent maintenance of ships and offshore systems"** and **"Smart and sustainable ship design and operation."** These two focus areas encapsulate the essential competencies required for future-ready maritime professionals, addressing both the digital and green dimensions of the transition. Developing targeted training courses in these areas will help ensure that maritime workforce is equipped to meet the evolving technical, operational, and environmental standards of the sector.

The application of the Deck of Cards Method (DCM) as part of a multi-criteria decision aiding (MCDA) approach proved to be a valuable tool in this context. It allowed for a structured and analytical prioritization of skill areas and training needs. Despite varying scenario weights, the consistency of results highlights the model's resilience and bolsters the strategic significance of the highest-rated skills, even with different scenario weights, such as *Integration of green technologies* and *Alternative Fuels*. These results offer a clear, evidence-based pathway for decision-makers and education providers to shape future training programs.

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APPENDIX I

DRAFT Working document

Date: March, 2025

WP3: Matching supply and demand. Identification of training and skills gaps and needs

WP1: Skills and training needs (Sur | Skill assessment | WP2: Assessment of existing training supply

Sector	Skill	Service	Role	Challenge impact		Skill Contribution		Target education	Training providers	Type of Training	Training Duration	Availability of	1. Industry-				2. Hands-On		3. Monitoring		4. Transferable		5. Certification		6. Capacity to		7. Scalability		
						Cybersecurity							Alignment with	Use of Industry-	Sector-	Forecasted	Work-Based	Simulations	Skills Outcome	Continuous	Soft Skills and	Adaptability to	Recognition by	Pathways to	Adaptability for	Lifelong	Broad	Scalability for	
Merchant shipping	Cybersecurity expertise	Maritime operations	Maritime IT	Digital	High Impact	Cybersecurity	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x				x	x	x	x	x	x	x	x	x	x	x	Ir
Merchant shipping				Innovation	High Impact	Data and analytics manag	High Impact																						Ir
Merchant shipping				Energy transitio	No impact	Automation and robotics	Low Impact																						Ir
Merchant shipping				Maritime decarb	No impact																								Ir
Merchant shipping	Shipboard Waste	Maritime operations	Management of the	Digital	No impact	Skills related to the energy	Low Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x				x	x	x	x	x	x	x					Ir
Merchant shipping				Innovation	Low Impact	Decarbonization	High Impact																						Ir
Merchant shipping				Energy transitio	Low Impact																								Ir
Merchant shipping				Maritime decarb	High Impact																								Ir
Merchant shipping	Ecological footprint of	Maritime operations	Management of the	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	Ir
Merchant shipping				Innovation	Low Impact	Decarbonization	High Impact																						Ir
Merchant shipping				Energy transitio	High Impact	Energy Management	High Impact																						Ir
Merchant shipping				Maritime decarb	High Impact																								Ir
Merchant shipping	Artificial intelligence	Maritime operations	Ship operation	Digital	High Impact	Virtual and augmented rea	High Impact	High-level education (Phd	Universities	Continuing	2 years	Not available																	Ir
Merchant shipping				Innovation	High Impact	Energy Management	Low Impact																						Ir
Merchant shipping				Energy transitio	Low Impact	Navigation	High Impact																						Ir
Merchant shipping				Maritime decarb	Low Impact																								Ir
Offshore energy	Operate underwater	Operation & Maintenance	Remote Operated	Digital	Low Impact	Automation and robotics	High Impact	Post-secondary (EQF level 5)	Maritime industry SMEs	Initial	40-180 h	Not adequate	x	x	x	x	x	x		x			x	x	x	x		x	Ir
Offshore energy				Innovation	Low Impact																								Ir
Offshore energy				Energy transitio	No impact																								Ir
Offshore energy				Maritime decarb	Low Impact																								Ir
Offshore energy	Offshore Wind Farm	Operation & Maintenance	MRE Maintenance	Digital	No impact	Skills related to the energy	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Apprenticeship	2 years	Not adequate	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	Ir
Offshore energy				Innovation	Low Impact																								Ir
Offshore energy				Energy transitio	High Impact																								Ir
Offshore energy				Maritime decarb	High Impact																								Ir
Offshore energy	Offshore Wind Farm	Operation & Maintenance	Maintenance Manager	Digital	Low Impact	Energy Management	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	Ir
Offshore energy				Innovation	Low Impact	Skills related to the energy	High Impact																						Ir
Offshore energy				Energy transitio	High Impact																								Ir
Offshore energy				Maritime decarb	High Impact																								Ir
Offshore energy	Sensor technology	Materials & Manufacturin	Electrical Engineers &	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Initial	3 years	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	Ir
Offshore energy				Innovation	High Impact	Energy Management	High Impact																						Ir
Offshore energy				Energy transitio	High Impact																								Ir
Offshore energy				Maritime decarb	High Impact																								Ir
Fishing	Route optimization	Intelligent and	AI & Smart Navigation	Digital	High Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not available																	Ir
Fishing				Innovation	Low Impact	Skills related to the energy	High Impact																						Ir
Fishing				Energy transitio	High Impact	Navigation	High Impact																						Ir
Fishing				Maritime decarb	High Impact																								Ir
Fishing	Intelligent navigation	Intelligent and	AI & Smart Navigation	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Continuing	1 year	Not available																	Ir
Fishing				Innovation	High Impact	Navigation	High Impact																						Ir
Fishing				Energy transitio	Low Impact																								Ir
Fishing				Maritime decarb	Low Impact																								Ir
Shipbuilding	3D modeling, printing and	Manufacturing	Machine engineers &	Digital	High Impact	Virtual and augmented rea	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not available																	FR
Shipbuilding				Innovation	High Impact	Data and analytics manag	Low Impact																						FR
Shipbuilding				Energy transitio	Low Impact	Automation and robotics	High Impact																						FR
Shipbuilding				Maritime decarb	Low Impact																								FR
Shipbuilding	Artificial Intelligence	Materials & Equipment &	Automation Engineer &	Digital	High Impact	AI	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not available																	FR
Shipbuilding				Innovation	High Impact	Virtual and augmented rea	High Impact																						FR
Shipbuilding				Energy transitio	Low Impact	Data and analytics manag	Low Impact																						FR
Shipbuilding				Maritime decarb	Low Impact	Automation and robotics	High Impact																						FR
Shipbuilding	Artificial Intelligence	Maintenance	Machine engineers &	Digital	High Impact	AI	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not available																	FR
Shipbuilding				Innovation	High Impact	Virtual and augmented rea	High Impact																						FR
Shipbuilding				Energy transitio	Low Impact	Data and analytics manag	Low Impact																						FR
Shipbuilding				Maritime decarb	Low Impact	Automation and robotics	High Impact																						FR
Shipbuilding	Internet of Things (IoT) -	Maintenance	Machine engineers &	Digital	High Impact	Automation and robotics	High Impact	High-level education	Vocational training centres	Continuing	40-180 h	Not available																	FR
Shipbuilding				Innovation	High Impact	Virtual and augmented rea	High Impact																						FR
Shipbuilding				Energy transitio	No impact	Data and analytics manag	High Impact																						FR
Shipbuilding				Maritime decarb	Low Impact	Logistics and supply chain	High Impact																						FR
Shipbuilding	Automation systems	Materials & Equipment &	Automation Engineer &	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Initial	...	Not adequate	x	x			x	x	x				x	x					FR
Shipbuilding				Innovation	High Impact	Data and analytics manag	High Impact																						FR
Shipbuilding				Energy transitio	High Impact	Skills related to the energy	Low Impact																						FR
Shipbuilding				Maritime decarb	No impact																								FR
Shipbuilding	Energy Efficiency &	Maritime Technologies	Systems Engineers	Digital	Low Impact	Energy Management	High Impact	High-level education	Universities	Continuing	40-180 h	Not adequate	x	x	x	x	x	x	x	x	x		x						FR
Shipbuilding				Innovation	High Impact	Skills related to the energy	High Impact																						FR
Shipbuilding				Energy transitio	High Impact	Decarbonization	Low Impact																						FR
Shipbuilding				Maritime decarb	High Impact	Automation and robotics	Low Impact																						FR
Shipbuilding	Alternative Fuels (e.g.	Maritime Technologies	Machine engineers &	Digital	No impact	Energy Management	High Impact	Secondary education (EQF	Vocational training centres	Initial	3 years	Not available																	FR
Shipbuilding				Innovation	Low Impact	Skills related to the energy	High Impact																						FR
Shipbuilding				Energy transitio	High Impact	Decarbonization	Low Impact																						FR
Shipbuilding				Maritime decarb	High Impact	Automation and robotics	Low Impact																						FR
Offshore energy	Design the foundations	Ocean engineering	Naval Architects	Digital	No impact	Skills related to the energy	High Impact	High-level education	Universities	Initial	2 years	Not adequate	x	x	x	x										x			FR
Offshore energy				Innovation	Low Impact	Decarbonization	High Impact																						FR
Offshore energy				Energy transitio	High Impact																								FR
Offshore energy				Maritime decarb	High Impact																								FR
Offshore energy	Design of turbines	Machine Engineering	Electrical Engineers &	Digital	No impact	Skills related to the energy	High Impact	High-level education	Universities	Initial	2 years	Not adequate	x	x	x	x										x			FR
Offshore energy				Innovation	Low Impact	Decarbonization	High Impact																						FR
Offshore energy				Energy transitio	High Impact																								FR
Offshore energy				Maritime decarb	High Impact																								FR
Offshore energy	Sensor technology	Operation & Maintenance	Maintenance Manager	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Initial	2 years	Not adequate	x	x	x	x	x	x	x	x	x	x	x	x					FR
Offshore energy				Innovation	High Impact	AI	High Impact																						FR
Offshore energy				Energy transitio	No impact	Automation and robotics	High Impact																						FR
Offshore energy				Maritime decarb	No impact	Cybersecurity	Low Impact																						FR
Offshore energy	Drones, ROV and	Operation & Maintenance	Remote Operated	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Initial	2 years	...	x	x	x	x	x	x	x	x								x	FR
Offshore energy				Innovation	High Impact	Logistics and supply chain	High Impact																						FR
Offshore energy				Energy transitio	No impact	Data and analytics manag	High Impact																						FR
Offshore energy				Maritime decarb	High Impact																								FR
Merchant shipping	Big data and data	Maritime operations	Ship operation	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Vocational training centres	Initial	3 years	Not available																	FR
Merchant shipping				Innovation	High Impact	Logistics and supply chain	High Impact																						FR
Merchant shipping				Energy transitio	No impact	Navigation	High Impact																						FR
Merchant shipping				Maritime decarb	High Impact	Automation and robotics	Low Impact																						FR
Merchant shipping	Cybersecurity expertise	Maritime operations	Maritime IT	Digital	High Impact	Cybersecurity	High Impact	High-level education	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x		x	x	x	x				x			FR
Merchant shipping				Innovation	No impact	Data and analytics manag	High Impact																						FR
Merchant shipping				Energy transitio	No impact	AI	High Impact																						FR
Merchant shipping				Maritime decarb	No impact																								FR
Merchant shipping	Artificial intelligence	Maritime operations	Ship operation	Digital	High Impact	AI	High Impact	High-level education	Vocational training centres	Continuing	180-1000 h	Not available																	FR
Merchant shipping				Innovation	Low Impact	Data and analytics manag	High Impact																						FR
Merchant shipping				Energy transitio	Low Impact	Automation and robotics	High Impact																						FR
Merchant shipping				Maritime decarb	Low Impact	Energy Management	Low Impact																						FR
Merchant shipping	Ecological footprint of	Maritime operations	Ship operation	Digital	Low Impact	Decarbonization	High Impact	High-level education	Vocational training centres	Initial	180-1000 h	Not available																	FR
Merchant shipping				Innovation	Low Impact	Navigation	High Impact																						FR
Merchant shipping				Energy transitio	Low Impact	Logistics and supply chain	High Impact																						FR
Merchant shipping				Maritime decarb	High Impact																								FR
Shipbuilding	*3D modeling, printing and*	*Ship design & conception*	*Naval architects*	Digital	Low Impact	Virtual and augmented rea	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	OK	x	x	x	x	x		x	x	x		x	x	x	x	x		BC
Shipbuilding				Innovation	High Impact	Data and analytics manag	Low Impact																						BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC

Shipbuilding	Life Cycle assessment	Ship design & construction	Naval architects	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	OK	x	x	x	x	x		x	x	x		x	x	x	x	x		BC
Shipbuilding				Innovation	High Impact	Energy Management	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Propulsion systems	Ship design & construction	Naval architects	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	OK	x	x	x	x	x		x	x	x		x	x	x	x	x		BC
Shipbuilding				Innovation	High Impact	Energy Management	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Energy Efficiency &	Ship design & construction	Naval architects	Digital	High Impact	Energy Management	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	OK	x	x	x	x	x		x	x	x		x	x	x	x	x		BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	High Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Robotics	Shipbuilding & ship repair	Naval Mechanics	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Automation systems	Shipbuilding & ship repair	Naval Mechanics	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Electrical, propulsion	Shipbuilding & ship repair	Naval Mechanics	Digital	High Impact	Energy Management	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Internet of Things (IoT)	Shipbuilding & ship repair	Naval Mechanics	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Shipbuilding				Innovation	High Impact	Automation and robotics	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	3D modeling, printing and	Development of digital	3D/4D simulation	Digital	High Impact	Virtual and augmented rea	High Impact	High-level education	Universities	Continuing	180-1000 h	Not available																	BC
Shipbuilding				Innovation	High Impact	Data and analytics manag	Low Impact																						BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Artificial Intelligence	Development of digital	3D/4D simulation	Digital	High Impact	Virtual and augmented rea	High Impact	High-level education	Universities	Continuing	180-1000 h	Not available																	BC
Shipbuilding				Innovation	High Impact	Data and analytics manag	High Impact																						BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Big Data, Sensor data	Development of digital	3D/4D simulation	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	180-1000 h	Not available																	BC
Shipbuilding				Innovation	High Impact	Automation and robotics	High Impact																						BC
Shipbuilding				Energy transitio	Low Impact	Cybersecurity	Low Impact																						BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Energy Efficiency &	Shipbuilding project	Project/Construction leaders	Digital	High Impact	Energy Management	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x		x			x	x	x	x		x		x		BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	High Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Development of Safe and	Shipbuilding project	Project/Construction leaders	Digital	Low Impact	Decarbonization	Low Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x	x			x	x	x	x		x		x		BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Environmental Impact	Shipbuilding project	Project/Construction leaders	Digital	High Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x	x			x	x	x	x		x		x		BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Surface treatment	Manufacturing	Metalworkers (Welders	Digital	Low Impact	Energy Management	Low Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x	x			x	x	x		x	x	BC
Shipbuilding				Innovation	Low Impact																								BC
Shipbuilding				Energy transitio	No impact																								BC
Shipbuilding				Maritime decarb	No impact																								BC

Shipbuilding	Composites materials	Manufacturing	Metalworkers (Welders	Digital	Low Impact	Skills related to the energy	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x	x			x	x	x		x	x	BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Technological	Manufacturing	Metalworkers (Welders	Digital	Low Impact	Energy Management	Low Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x	x			x	x	x		x	x	BC
Shipbuilding				Innovation	High Impact	Decarbonization	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Mechanical, electrical	Manufacturing	Pipe fitters	Digital	Low Impact	Energy management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x		x			x	x	x		x	x	BC
Shipbuilding				Innovation	Low Impact	Decarbonization	High Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Technological	Manufacturing	Pipe fitters	Digital	Low Impact	Energy Management	Low Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x		x			x	x	x		x	x	BC
Shipbuilding				Innovation	High Impact	Decarbonization	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Condition-based	Maintenance	Naval mechanics	Digital	High Impact	Data and analytics manag	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x	x	x				x	x	x		x	x	BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Mechanical, electrical	Maintenance	Naval mechanics	Digital	Low Impact	Energy management	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x	x	x				x	x	x		x	x	BC
Shipbuilding				Innovation	Low Impact	Decarbonization	High Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Big Data, Sensor data	Maintenance	Naval mechanics	Digital	High Impact	Data and analytics manag	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x	x	x				x	x	x		x	x	BC
Shipbuilding				Innovation	High Impact	Automation and robotics	High Impact																						BC
Shipbuilding				Energy transitio	Low Impact	Cybersecurity	Low Impact																						BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	3D modeling, printing and	Conception & Design	Industrial designers	Digital	High Impact	Virtual and augmented rea	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	Not adequate	x	x	x			x	x	x	x	x	X		X		x		BC
Shipbuilding				Innovation	High Impact	Data and analytics manag	Low Impact																						BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Life Cycle Assessment	Conception & Design	Industrial designers	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	Not adequate	x	x	x			x	x	x	x	x	X		X		x		BC
Shipbuilding				Innovation	High Impact	Energy Management	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Mechanical, electrical	Maritime Technologies	Structural Engineers	Digital	Low Impact	Energy management	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x			X	X	X	X	X		BC
Shipbuilding				Innovation	Low Impact	Decarbonization	High Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Propulsion systems	Maritime Technologies	Structural Engineers	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x			X	X	X	X	X		BC
Shipbuilding				Innovation	High Impact	Energy Management	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Internet of Things (IoT)	Development of digital	Systems Engineers	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	X	X	X	X	X		BC
Shipbuilding				Innovation	High Impact	Automation and robotics	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Big Data, Sensor data	Development of digital	Systems Engineers	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	X	X	X	X	X		BC
Shipbuilding				Innovation	High Impact	Automation and robotics	High Impact																						BC
Shipbuilding				Energy transitio	Low Impact	Cybersecurity	Low Impact																						BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Automation systems	Development of digital	Systems Engineers	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	X	X	X	X	X		BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC

Shipbuilding	Electrical, propulsion	Shipbuilding & ship repair	Electronic Engineers &	Digital	High Impact	Energy Management	High Impact	High-level education	Universities	Initial & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x		x	X	X	X	X	X		BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Technological	Shipbuilding & ship repair	Electronic Engineers &	Digital	Low Impact	Energy Management	Low Impact	High-level education	Universities	Initial & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x		x	X	X	X	X	X		BC
Shipbuilding				Innovation	High Impact	Decarbonization	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Mechanical, electrical	Shipbuilding & ship repair	Machine engineers &	Digital	Low Impact	Energy management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x	x	x	x	x		x	x	x	X	x		x	X	BC
Shipbuilding				Innovation	Low Impact	Decarbonization	High Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Condition-based	Shipbuilding & ship repair	Machine engineers &	Digital	High Impact	Data and analytics manag	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x	x	x	x	x		x	x	x	X	x		x	X	BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Robotics	Development of digital	Automation Engineer &	Digital	High Impact	Automation and robotics	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	x	x	x		X	X	X	X	X		BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Automation systems	Development of digital	Automation Engineer &	Digital	High Impact	Automation and robotics	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	x	x	x		X	X	X	X	X		BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Artificial Intelligence	Development of digital	Automation Engineer &	Digital	High Impact	Virtual and augmented rea	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	x	x	x		X	X	X	X	X		BC
Shipbuilding				Innovation	High Impact	Data and analytics manag	High Impact																						BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Alternative Fuels (e.g.	Propulsion & Energy	Alternative fuels	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Emission control	Propulsion & Energy	Alternative fuels	Digital	High Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Composites materials	Materials & Equipment &	Composite specialists	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Initial	4 years	Not adequate	x	x	x		x	x		x	x		x		X		X		BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Surface treatment	Materials & Equipment &	Composite specialists	Digital	No impact	Energy Management	Low Impact	High-level education	Universities	Initial	4 years	Not adequate	x	x	x		x	x		x	x		x		X		X		BC
Shipbuilding				Innovation	Low Impact																								BC
Shipbuilding				Energy transitio	No impact																								BC
Shipbuilding				Maritime decarb	No impact																								BC
Shipbuilding	Surface treatment	Manufacturing	Naval Carpenters (	Digital	No impact	Energy Management	Low Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x	x	x	x			X	X	X		X	X	BC
Shipbuilding				Innovation	Low Impact																								BC
Shipbuilding				Energy transitio	No impact																								BC
Shipbuilding				Maritime decarb	No impact																								BC
Shipbuilding	Technological	Manufacturing	Naval Carpenters (	Digital	Low Impact	Energy Management	Low Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x	x	x	x			X	X	X		X	X	BC
Shipbuilding				Innovation	High Impact	Decarbonization	Low Impact																						BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Electrical, propulsion	Shipbuilding & ship repair	Assembly professions	Digital	High Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x				X	X	X		X	X	BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC

Shipbuilding	Technologic al	Shipbuilding & ship repair	Assembly professionals	Digital	Low Impact	Energy Management	Low Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x				x	x	x		x	x	BC
Shipbuilding				Innovation	High Impact	Decarbonization	Low Impact																						BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Life Cycle Assessment	Ship Recycling &	Sustainabili	Digital	High Impact	Decarbonization	High Impact	High-level education	Universities	Initial	4 years	Not available																	BC
Shipbuilding				Innovation	High Impact	Energy Management	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Environment al Impact	Ship Recycling &	Sustainabili	Digital	High Impact	Decarbonization	High Impact	High-level education	Universities	Initial	4 years	Not available																	BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Development of Safe and	Ship Recycling &	Conversion Processes	Digital	No impact	Decarbonization	Low Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not available																	BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Emission control	Ship Recycling &	Conversion Processes	Digital	High Impact	Decarbonization	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not available																	BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Development of Safe and	Decommissio ning	Port jobs	Digital	No impact	Decarbonization	Low Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK			x		x		x	x	x		x		x		x		BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Environment al Impact	Decommissio ning	Port jobs	Digital	High Impact	Decarbonization	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK			x		x		x	x	x		x		x		x		BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Condition-based	Maintenance	Support professionals	Digital	High Impact	Data and analytics manag	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate			x		x		x	x	x	x							BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Mechanical, electrical	Maintenance	Support professionals	Digital	No impact	Energy management	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate			x		x		x	x	x	x							BC
Shipbuilding				Innovation	Low Impact	Decarbonization	High Impact																						BC
Shipbuilding				Energy transitio	No impact																								BC
Shipbuilding				Maritime decarb	No impact																								BC
Shipbuilding	Propulsion systems	Propulsion & Energy	Propulsion & Energy	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Shipbuilding				Innovation	High Impact	Energy Management	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Energy Efficiency &	Propulsion & Energy	Propulsion & Energy	Digital	High Impact	Energy Management	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	High Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Electrical,	Electrical systems	Naval electricians	Digital	High Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x	x	x		x	x	x		x	x	BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC
Shipbuilding	Automation systems	Electrical systems	Naval electricians	Digital	High Impact	Automation and robotics	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x	x	x		x	x	x		x	x	BC
Shipbuilding				Innovation	High Impact																								BC
Shipbuilding				Energy transitio	Low Impact																								BC
Shipbuilding				Maritime decarb	Low Impact																								BC
Shipbuilding	Energy Efficiency &	Electrical systems	Naval electricians	Digital	High Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x	x	x		x	x	x		x	x	BC
Shipbuilding				Innovation	High Impact	Skills related to the energy	High Impact																						BC
Shipbuilding				Energy transitio	High Impact																								BC
Shipbuilding				Maritime decarb	High Impact																								BC

Merchant shipping	Big data and data	Logistics & supply chain	Cloud computing	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	Low Impact																								BC
Merchant shipping				Maritime decarb	Low Impact																								BC
Merchant shipping	Cybersecurity expertise	Logistics & supply chain	Cloud computing	Digital	High Impact	Cybersecurity	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Cybersecurity expertise	Maritime systems &	Cybersecurity engineers	Digital	High Impact	Cybersecurity	High Impact	High-level education	Universities	Initial	4 years	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x		BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Artificial intelligence	Maritime systems &	Cybersecurity engineers	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Initial	4 years	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x		BC
Merchant shipping				Innovation	High Impact	Virtual and augmented rea	Low Impact																						BC
Merchant shipping				Energy transitio	Low Impact																								BC
Merchant shipping				Maritime decarb	Low Impact																								BC
Merchant shipping	Managerial and project	Maritime operations	Management of maritime	Digital	Low Impact	Energy Management	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x		x		x	x	x	x	x		x		x		BC
Merchant shipping				Innovation	Low Impact																								BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Communication	Maritime operations	Management of maritime	Digital	Low Impact	Logistics and supply chain	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x		x		x	x	x	x	x		x		x		BC
Merchant shipping				Innovation	Low Impact	Navigation	High Impact																						BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Health and Safety	Maritime operations	Management of maritime	Digital	Low Impact	Energy Management	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x		x		x	x	x	x	x		x		x		BC
Merchant shipping				Innovation	Low Impact																								BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Ecological footprint of	Optimization of shipping	Management of the	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x		x			x	x	x	x	x		x		x		BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	High Impact																								BC
Merchant shipping				Maritime decarb	High Impact																								BC
Merchant shipping	Shipboard Waste	Optimization of shipping	Management of the	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x		x			x	x	x	x	x		x		x		BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	High Impact																								BC
Merchant shipping				Maritime decarb	High Impact																								BC
Merchant shipping	Maritime environment	Optimization of shipping	Management of the	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x		x			x	x	x	x	x		x		x		BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	High Impact																								BC
Merchant shipping				Maritime decarb	High Impact																								BC
Merchant shipping	Cybersecurity expertise	Maritime systems &	Maritime IT	Digital	High Impact	Cybersecurity	High Impact	High-level education	Universities	Initial	4 years	Not available																	BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Artificial intelligence	Maritime systems &	Maritime IT	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Initial	4 years	Not available																	BC
Merchant shipping				Innovation	High Impact	Virtual and augmented rea	Low Impact																						BC
Merchant shipping				Energy transitio	Low Impact																								BC
Merchant shipping				Maritime decarb	Low Impact																								BC
Merchant shipping	Artificial intelligence	Optimization of shipping	Autonomous vessels	Digital	High Impact	Data and analytics manag	High Impact	Post-secondary (EQF level 5)	Universities	Continuing	1 year	Not available																	BC
Merchant shipping				Innovation	High Impact	Virtual and augmented rea	Low Impact																						BC
Merchant shipping				Energy transitio	Low Impact																								BC
Merchant shipping				Maritime decarb	Low Impact																								BC
Merchant shipping	Big data and data	Optimization of shipping	Autonomous vessels	Digital	High Impact	Data and analytics manag	High Impact	Post-secondary (EQF level 5)	Universities	Continuing	1 year	Not available																	BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	Low Impact																								BC
Merchant shipping				Maritime decarb	Low Impact																								BC

Merchant shipping	On-board / offshore	Logistics & supply chain	Port operator	Digital	Low Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x		x	x	x		x		x		x		BC
Merchant shipping				Innovation	Low Impact																								BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Health and Safety	Logistics & supply chain	Port operator	Digital	Low Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x		x	x	x		x		x		x		BC
Merchant shipping				Innovation	Low Impact																								BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Quality, hygiene	Logistics & supply chain	Port operator	Digital	Low Impact	Decarbonization	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x		x	x	x		x		x		x		BC
Merchant shipping				Innovation	Low Impact																								BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Communication	Maritime operations	Ship operation	Digital	Low Impact	Logistics and supply chain	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x	x	x	x	x	x	x	x		x		x		BC
Merchant shipping				Innovation	Low Impact	Navigation	High Impact																						BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Managerial and project	Maritime operations	Ship operation	Digital	Low Impact	Energy Management	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x	x	x	x	x	x	x	x		x		x		BC
Merchant shipping				Innovation	Low Impact																								BC
Merchant shipping				Energy transitio	No impact																								BC
Merchant shipping				Maritime decarb	No impact																								BC
Merchant shipping	Big data and data	Maritime operations	Ship operation	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x	x	x	x	x	x	x	x		x		x		BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	Low Impact																								BC
Merchant shipping				Maritime decarb	Low Impact																								BC
Merchant shipping	Big data and data	Optimization of shipping	Maritime surveillance	Digital	High Impact	Data and analytics manag	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Continuing	40 - 180 h	Not available																	BC
Merchant shipping				Innovation	High Impact																								BC
Merchant shipping				Energy transitio	Low Impact																								BC
Merchant shipping				Maritime decarb	Low Impact																								BC
Merchant shipping	Ecological footprint of	Optimization of shipping	Maritime surveillance	Digital	Low Impact	Decarbonization	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Continuing	40 - 180 h	Not available																	BC
Merchant shipping				Innovation	High Impact	Skills related to the energy	High Impact																						BC
Merchant shipping				Energy transitio	High Impact																								BC
Merchant shipping				Maritime decarb	High Impact																								BC
Merchant shipping	Artificial intelligence	Optimization of shipping	Maritime surveillance	Digital	High Impact	Data and analytics manag	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Continuing	40 - 180 h	Not available																	BC
Merchant shipping				Innovation	High Impact	Virtual and augmented rea	Low Impact																						BC
Merchant shipping				Energy transitio	Low Impact																								BC
Merchant shipping				Maritime decarb	Low Impact																								BC
Fishing	Navigation and	Maintenance and	Naval Mechatronic	Digital	High Impact	Logistics and supply chain	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Fishing				Innovation	High Impact	Navigation	High Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Intelligent navigation	Maintenance and	Naval Mechatronic	Digital	High Impact	Navigation	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Fishing				Innovation	High Impact	Data and analytics manag	Low Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Automation systems	Maintenance and	Naval Mechatronic	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	Not adequate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Fishing				Innovation	High Impact																								BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Route optimization	Maintenance and repair of	Naval Mechanics	Digital	High Impact	Logistics and supply chain	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x		x		x	x	x				x	x	x		x	x	BC
Fishing				Innovation	High Impact																								BC
Fishing				Energy transitio	High Impact																								BC
Fishing				Maritime decarb	High Impact																								BC
Fishing	Mechanical, electrical	Maintenance and repair of	Naval Mechanics	Digital	Low Impact	Energy management	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x		x		x	x	x				x	x	x		x	x	BC
Fishing				Innovation	Low Impact	Decarbonization	High Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC

Fishing	Electronic Chart	Installation and	Naval Electricians	Digital	High Impact	Navigation	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x	x	x		x	x	x		x	x	BC
Fishing				Innovation	Low Impact																								BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Global Maritime	Installation and	Naval Electricians	Digital	High Impact	Navigation	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x	x	x		x	x	x		x	x	BC
Fishing				Innovation	Low Impact																								BC
Fishing				Energy transitio	No impact																								BC
Fishing				Maritime decarb	No impact																								BC
Fishing	Electrical, propulsion	Installation and	Naval Electricians	Digital	High Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	OK	x	x	x		x	x	x	x	x		x	x	x		x	x	BC
Fishing				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Mechanical, electrical	Maintenance and	Fishing Vessel	Digital	Low Impact	Energy management	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x	x	x	x	x		x		x		x	x	BC
Fishing				Innovation	Low Impact	Decarbonization	High Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Data Analytics	Maintenance and	Fishing Vessel	Digital	High Impact	Data and analytics manag	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x	x	x	x	x		x		x		x	x	BC
Fishing				Innovation	High Impact																								BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Health and Safety	Management of onboard	Onboard Safety	Digital	Low Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Continuing	40-180 h	OK	x	x	x		x	x	x	x	x		x	x	x		x	x	BC
Fishing				Innovation	Low Impact																								BC
Fishing				Energy transitio	No impact																								BC
Fishing				Maritime decarb	No impact																								BC
Fishing	On-board / Offshore	Management of onboard	Onboard Safety	Digital	Low Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Continuing	40-180 h	OK	x	x	x		x	x	x	x	x		x	x	x		x	x	BC
Fishing				Innovation	Low Impact																								BC
Fishing				Energy transitio	No impact																								BC
Fishing				Maritime decarb	No impact																								BC
Fishing	Data Analytics	Optimization of fishing	Big Data Experts &	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x		BC
Fishing				Innovation	High Impact																								BC
Fishing				Energy transitio	High Impact																								BC
Fishing				Maritime decarb	High Impact																								BC
Fishing	Big Data, Sensor data	Optimization of fishing	Big Data Experts &	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x		BC
Fishing				Innovation	High Impact	Automation and robotics	High Impact																						BC
Fishing				Energy transitio	High Impact	Cybersecurity	Low Impact																						BC
Fishing				Maritime decarb	High Impact																								BC
Fishing	Sustainable Fishing	Management of daily	Fishing Operations	Digital	Low Impact	Decarbonization	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x		x	x	x	x	x		x		x	x	BC
Fishing				Innovation	Low Impact																								BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Managerial and project	Management of daily	Fishing Operations	Digital	Low Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x		x	x	x	x	x		x		x	x	BC
Fishing				Innovation	Low Impact																								BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Environmental impact	Management of daily	Fishing Operations	Digital	Low Impact	Decarbonization	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x		x	x	x	x	x		x		x	x	BC
Fishing				Innovation	Low Impact	Skills related to the energy	Low Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Sustainable Fishing	Promotion of sustainable	Maritime Environment	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x		x				x	x	x	x	x		x		x		BC
Fishing				Innovation	Low Impact																								BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Environmental expertise	Promotion of sustainable	Maritime Environment	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x		x				x	x	x	x	x		x		x		BC
Fishing				Innovation	Low Impact	Skills related to the energy	High Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC

Fishing	Intelligent navigation	Implementation of	AI & Smart Navigation	Digital	High Impact	Navigation	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Fishing				Innovation	High Impact	Data and analytics manag	Low Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Artificial intelligence	Implementation of	AI & Smart Navigation	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Fishing				Innovation	High Impact	Virtual and augmented rea	Low Impact																						BC
Fishing				Energy transitio	High Impact																								BC
Fishing				Maritime decarb	High Impact																								BC
Fishing	Drones, ROV and	Underwater inspection	ROV & Drone Operators	Digital	High Impact	Automation and robotics	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Continuing	40-180 h	Not available																	BC
Fishing				Innovation	High Impact	Navigation	High Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Sensor technology	Underwater inspection	ROV & Drone Operators	Digital	High Impact	Data and analytics manag	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Continuing	40-180 h	Not available																	BC
Fishing				Innovation	High Impact	Automation and robotics	High Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Electronic Chart	Design and maintenance	Electronic Systems	Digital	High Impact	Navigation	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Fishing				Innovation	Low Impact																								BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Navigation and	Design and maintenance	Electronic Systems	Digital	High Impact	Logistics and supply chain	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Fishing				Innovation	High Impact	Navigation	High Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Electrical, propulsion	Design and maintenance	Electronic Systems	Digital	High Impact	Energy Management	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Fishing				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Sustainable Fishing	Promotion of sustainable	Marine Biologists &	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x	x	x	x	x	x		x		x		x		BC
Fishing				Innovation	Low Impact																								BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Fishing	Environmental impact	Promotion of sustainable	Marine Biologists &	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x	x	x	x	x	x		x		x		x		BC
Fishing				Innovation	Low Impact	Skills related to the energy	Low Impact																						BC
Fishing				Energy transitio	Low Impact																								BC
Fishing				Maritime decarb	Low Impact																								BC
Offshore energy	Expertise in subsea	Offshore installation	Multi-technology	Digital	High Impact	Skills related to the energy	High Impact	Post-secondary (EQF level 5)	Universities	Initial	2 years	Not adequate	x	x	x	x	x	x	x	x	x		x	x	x		x		BC
Offshore energy				Innovation	High Impact	Navigation	Low Impact																						BC
Offshore energy				Energy transitio	Low Impact																								BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Design of electrical	Offshore installation	Multi-technology	Digital	High Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Universities	Initial	2 years	Not adequate	x	x	x	x	x	x	x	x	x		x	x	x		x		BC
Offshore energy				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Design the foundations	Operations & Maintenance	Offshore wind farm	Digital	Low Impact	Skills related to the energy	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	x	x	x		x	x	x		x		BC
Offshore energy				Innovation	Low Impact																								BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Sensor technology	Operations & Maintenance	Offshore wind farm	Digital	High Impact	Data and analytics manag	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	x	x	x		x	x	x		x		BC
Offshore energy				Innovation	High Impact	Automation and robotics	High Impact																						BC
Offshore energy				Energy transitio	Low Impact																								BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Environmental expertise	Civil engineering	Civil Engineering	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Initial	4 years	OK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Offshore energy				Innovation	Low Impact	Skills related to the energy	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC

Offshore energy	Design the foundations	Civil engineering	Civil Engineering	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Initial	4 years	OK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Offshore energy				Innovation	High Impact																								BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Design of turbines	Machine Engineering	Mechanical Engineers	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Offshore energy				Innovation	High Impact																								BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Energy efficiency &	Machine Engineering	Mechanical Engineers	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Offshore energy				Innovation	High Impact	Energy Management	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Design of electrical	Electrotechnics	Electrical Engineers &	Digital	High Impact	Energy Management	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Offshore energy				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Energy efficiency &	Electrotechnics	Electrical Engineers &	Digital	High Impact	Skills related to the energy	High Impact	High-level education	Universities	Inital & apprenticeship	4 years	OK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		BC
Offshore energy				Innovation	High Impact	Energy Management	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Expertise in subsea	Ocean engineering	Subsea engineers	Digital	High Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Offshore energy				Innovation	High Impact	Navigation	Low Impact																						BC
Offshore energy				Energy transitio	Low Impact																								BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Sensor technology	Ocean engineering	Subsea engineers	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Offshore energy				Innovation	High Impact	Automation and robotics	High Impact																						BC
Offshore energy				Energy transitio	Low Impact																								BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Expertise in subsea	Structures and	Welders, underwater	Digital	Low Impact	Skills related to the energy	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not available																	BC
Offshore energy				Innovation	Low Impact	Navigation	Low Impact																						BC
Offshore energy				Energy transitio	Low Impact																								BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Environmental expertise	Sustainability & maritime	Marine surveyors	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x		X		X	X	X	X	x		x		x		BC
Offshore energy				Innovation	Low Impact	Skills related to the energy	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Energy efficiency &	Sustainability & maritime	Marine surveyors	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x		X		X	X	X	X	x		x		x		BC
Offshore energy				Innovation	Low Impact	Energy Management	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Sensor technology	Offshore infrastructure	MRE Maintenance	Digital	High Impact	Data and analytics manag	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	X		X		x	x	x		x		BC
Offshore energy				Innovation	High Impact	Automation and robotics	High Impact																						BC
Offshore energy				Energy transitio	Low Impact																								BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Design of electrical	Offshore infrastructure	MRE Maintenance	Digital	High Impact	Energy Management	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	X		X		x	x	x		x		BC
Offshore energy				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Design of turbines	Operations & Maintenance	Marine mechanics	Digital	Low Impact	Skills related to the energy	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x	x	X		X	X	x	x	x		x	x	BC
Offshore energy				Innovation	Low Impact																								BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Energy efficiency &	Operations & Maintenance	Marine mechanics	Digital	Low Impact	Skills related to the energy	High Impact	Secondary education (EQF	Vocational training centres	Initial	2 years	Not adequate	x	x	x		x	x	X		X	X	x	x	x		x	x	BC
Offshore energy				Innovation	Low Impact	Energy Management	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC

Offshore energy	Energy efficiency &	Development of digital	Data analysts	Digital	High Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x	x		x	x	x	x	x	x	x	x	x		BC
Offshore energy				Innovation	High Impact	Energy Management	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Environmental expertise	Sustainability & maritime	Alternative fuels	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Offshore energy				Innovation	Low Impact	Skills related to the energy	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Design of electrical	Sustainability & maritime	Alternative fuels	Digital	High Impact	Energy Management	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Offshore energy				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Expertise in subsea	Offshore infrastructure	Offshore platform	Digital	High Impact	Skills related to the energy	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	x		x		x	x	x		x		BC
Offshore energy				Innovation	High Impact	Navigation	Low Impact																						BC
Offshore energy				Energy transitio	Low Impact																								BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Sensor technology	Offshore infrastructure	Offshore platform	Digital	High Impact	Data and analytics manag	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	x		x		x	x	x		x		BC
Offshore energy				Innovation	High Impact	Automation and robotics	High Impact																						BC
Offshore energy				Energy transitio	Low Impact																								BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Operate underwater	Offshore infrastructure	Offshore platform	Digital	High Impact	Automation and robotics	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	x		x		x	x	x		x		BC
Offshore energy				Innovation	High Impact																								BC
Offshore energy				Energy transitio	Low Impact																								BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Drones, ROV and	Offshore infrastructure	Offshore platform	Digital	High Impact	Automation and robotics	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Initial	2 years	Not adequate	x	x	x	x	x	x	x		x		x	x	x		x		BC
Offshore energy				Innovation	High Impact	Navigation	High Impact																						BC
Offshore energy				Energy transitio	Low Impact	Data and analytics manag	Low Impact																						BC
Offshore energy				Maritime decarb	Low Impact																								BC
Offshore energy	Environmental expertise	Management of offshore	Offshore energy	Digital	Low Impact	Decarbonization	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Offshore energy				Innovation	Low Impact	Skills related to the energy	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Design the foundations	Management of offshore	Offshore energy	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Offshore energy				Innovation	High Impact																								BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Energy efficiency &	Management of offshore	Offshore energy	Digital	Low Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not available																	BC
Offshore energy				Innovation	High Impact	Energy Management	High Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Design of turbines	Development of digital	Hydrogen engineers	Digital	High Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x					x						x		BC
Offshore energy				Innovation	High Impact																								BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Design of electrical	Development of digital	Hydrogen engineers	Digital	High Impact	Energy Management	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x					x						x		BC
Offshore energy				Innovation	High Impact	Skills related to the energy	Low Impact																						BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC
Offshore energy	Alternative fuels	Development of digital	Hydrogen engineers	Digital	High Impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	1 year	Not adequate	x	x	x	x					x						x		BC
Offshore energy				Innovation	High Impact																								BC
Offshore energy				Energy transitio	High Impact																								BC
Offshore energy				Maritime decarb	High Impact																								BC

Shipbuilding	Big Data, Sensor data	Maintenance	Mechanical Engineers	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Continuing	2 years	Not adequate		x	x				x	x	x	x	x	x	x	x	x	x	Pt
Shipbuilding				Innovation	High Impact	Data and analytics manag	High Impact																						Pt
Shipbuilding				Energy transitio	No impact	Logistics and supply chain	High Impact																						Pt
Shipbuilding				Maritime decarb	Low Impact																								Pt
Shipbuilding	Artificial Intelligence	Maintenance	Mechanical Engineers	Digital	High Impact	Virtual and augmented rea	High Impact	High-level education	Universities	Continuing	2 years	Not adequate		x	x				x	x	x	x	x	x	x	x	x	x	Pt
Shipbuilding				Innovation	High Impact	Data and analytics manag	Low Impact																						Pt
Shipbuilding				Energy transitio	No impact																								Pt
Shipbuilding				Maritime decarb	No impact																								Pt
Shipbuilding	Alternative Fuels (e.g.	Maritime Technologies	Alternative fuels	Digital	No impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	2 years	Not available																	Pt
Shipbuilding				Innovation	High Impact	Decarbonization	High Impact																						Pt
Shipbuilding				Energy transitio	High Impact	Energy Management	High Impact																						Pt
Shipbuilding				Maritime decarb	High Impact																								Pt
Shipbuilding	Composites materials	Materials & Equipment &	Composite specialists	Digital	No impact			High-level education	Universities	Continuing	2 years	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	Pt
Shipbuilding				Innovation	High Impact																								Pt
Shipbuilding				Energy transitio	No impact																								Pt
Shipbuilding				Maritime decarb	Low Impact																								Pt
Shipbuilding	Life cycle Assessment	Ship Recycling &	Structural Engineers	Digital	No impact	Decarbonization	High Impact	High-level education	Universities	Continuing	2 years	Not adequate	x	x	x	x			x	x	x	x	x	x	x	x	x	x	Pt
Shipbuilding				Innovation	High Impact	Energy Management	High Impact																						Pt
Shipbuilding				Energy transitio	Low Impact																								Pt
Shipbuilding				Maritime decarb	High Impact																								Pt
Shipbuilding	Propulsion systems (e.g.	Conception & Design	Mechanical Engineers	Digital	No impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	2 years	Not adequate	x	x	x				x		x		x	x	x	x	x	x	Pt
Shipbuilding				Innovation	High Impact	Decarbonization	High Impact																						Pt
Shipbuilding				Energy transitio	High Impact	Energy Management	High Impact																						Pt
Shipbuilding				Maritime decarb	High Impact	Navigation	Low Impact																						Pt
Merchant shipping	Big data and data	Maritime operations	Ship operators	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	2 years	Not adequate		x	x	x			x	x	x	x	x	x	x	x	x	x	Pt
Merchant shipping				Innovation	Low Impact	Automation and robotics	High Impact																						Pt
Merchant shipping				Energy transitio	No impact	Logistics and supply chain	High Impact																						Pt
Merchant shipping				Maritime decarb	Low Impact	Navigation	Low Impact																						Pt
Merchant shipping	Cybersecurity	Maritime operations	Maritime IT	Digital	High Impact	Cybersecurity	High Impact	High-level education	Universities	Continuing	2 years	Not available																	Pt
Merchant shipping				Innovation	High Impact	Data and analytics manag	High Impact																						Pt
Merchant shipping				Energy transitio	No impact																								Pt
Merchant shipping				Maritime decarb	No impact																								Pt
Merchant shipping	Artificial Intelligence	Maritime operations	Autonomous vessels	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	2 years	Not available																	Pt
Merchant shipping				Innovation	High Impact	Navigation	High Impact																						Pt
Merchant shipping				Energy transitio	No impact	Logistics and supply chain	High Impact																						Pt
Merchant shipping				Maritime decarb	Low Impact	Automation and robotics	High Impact																						Pt
Merchant shipping	Big data and data	Maritime operations	Management of maritime	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	2 years	Not adequate		x	x	x			x	x	x	x	x	x	x	x	x	x	Pt
Merchant shipping				Innovation	Low Impact	Navigation	High Impact																						Pt
Merchant shipping				Energy transitio	No impact	Logistics and supply chain	High Impact																						Pt
Merchant shipping				Maritime decarb	Low Impact	Automation and robotics	Low Impact																						Pt
Fishing	Intelligent navigation	Intelligent and	AI & Smart Navigation	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	2 years	Not available		x	x				x		x	x	x	x	x	x	x	x	Pt
Fishing				Innovation	High Impact	Automation and robotics	High Impact																						Pt
Fishing				Energy transitio	Low Impact	Navigation	High Impact																						Pt
Fishing				Maritime decarb	Low Impact	Logistics and supply chain	Low Impact																						Pt
Offshore energy	Design the foundations	Structures and	Naval Architects	Digital	No impact	Energy Management	Low Impact	High-level education	Universities	Continuing	2 years	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	Pt
Offshore energy				Innovation	Low Impact	Skills related to the energy	High Impact																						Pt
Offshore energy				Energy transitio	High Impact	Decarbonization	High Impact																						Pt
Offshore energy				Maritime decarb	High Impact																								Pt
Offshore energy	Expertise in subsea	Ocean engineering	Subsea engineers	Digital	No impact	Data and analytics manag	Low Impact	High-level education	Universities	Continuing	2 years	Not available																	Pt
Offshore energy				Innovation	High Impact	Skills related to the energy	High Impact																						Pt
Offshore energy				Energy transitio	Low Impact																								Pt
Offshore energy				Maritime decarb	No impact																								Pt
Offshore energy	Sensor technology	Operations & Maintenance	Mechanical Engineers	Digital	High Impact	Virtual and augmented rea	High Impact	High-level education	Universities	Continuing	2 years	Not adequate	x	x	x	x			x	x	x	x	x	x	x	x	x	x	Pt
Offshore energy				Innovation	High Impact	Data and analytics manag	High Impact																						Pt
Offshore energy				Energy transitio	No impact																								Pt
Offshore energy				Maritime decarb	No impact																								Pt
Offshore energy	Operate underwater	Operations & Maintenance	Remote Operated	Digital	Low Impact	Navigation	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Apprenticeship	2 years	Not available					x												Pt
Offshore energy				Innovation	High Impact	Automation and robotics	Low Impact																						Pt
Offshore energy				Energy transitio	Low Impact	Logistics and supply chain	Low Impact																						Pt
Offshore energy				Maritime decarb	No impact																								Pt

Offshore energy	Environment expertise	Offshore installation	Marine surveyors	Digital	No impact	Decarbonization	High Impact	High-level education	Universities	Continuing	2 years	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	Pt
Offshore energy				Innovation	Low Impact	Data and analytics manag	Low Impact																						Pt
Offshore energy				Energy transitio	High Impact	Skills related to the energy	Low Impact																						Pt
Offshore energy				Maritime decarb	High Impact																								Pt
Offshore energy	Design the foundations	Ocean engineering	Naval Architects	Digital	No impact	Skills related to the energy	High Impact	High-level education	Universities	Continuing	2 years	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	Pt
Offshore energy				Innovation	High Impact	Decarbonization	Low Impact																						Pt
Offshore energy				Energy transitio	High Impact																								Pt
Offshore energy				Maritime decarb	High Impact																								Pt
Shipbuilding	Alternative Fuels (e.g.	Operation & Maintenance	Risk Analyst	Digital	No impact	Data and analytics manag	Low Impact	High-level education	Universities	Continuing	2 years	Not available																	Pt
Shipbuilding				Innovation	High Impact	Skills related to the energy	Low Impact																						Pt
Shipbuilding				Energy transitio	High Impact	Decarbonization	High Impact																						Pt
Shipbuilding				Maritime decarb	Low Impact	Energy Management	High Impact																						Pt
Shipbuilding	Human-centered	Conception & Design	Human Factor	Digital	No impact	Virtual and augmented rea	Low Impact	High-level education	Universities	Continuing	2 years	Not available																	Pt
Shipbuilding				Innovation	Low Impact	Logistics and supply chain	Low Impact																						Pt
Shipbuilding				Energy transitio	No impact	Navigation	Low Impact																						Pt
Shipbuilding				Maritime decarb	No impact																								Pt
Shipbuilding	Human-centered	Conception & Design	Naval architects	Digital	No impact	Virtual and augmented rea	Low Impact	High-level education	Universities	Continuing	2 years	Not adequate	x	x	x	x			x	x	x	x	x	x	x	x	x	x	Pt
Shipbuilding				Innovation	High Impact	Logistics and supply chain	Low Impact																						Pt
Shipbuilding				Energy transitio	Low Impact	Navigation	Low Impact																						Pt
Shipbuilding				Maritime decarb	No impact																								Pt
Shipbuilding	Automation systems	Materials & Equipment &	Mechanical Engineers	Digital	High Impact	Automation and robotics	High Impact	High-level education	Universities	Continuing	2 years	Not available																	Pt
Shipbuilding				Innovation	High Impact	Data and analytics manag	Low Impact																						Pt
Shipbuilding				Energy transitio	No impact																								Pt
Shipbuilding				Maritime decarb	Low Impact																								Pt
Shipbuilding	Automation systems	Maritime Technologies	Reliability Engineer	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	2 years	Not available																	Pt
Shipbuilding				Innovation	High Impact	Automation and robotics	High Impact																						Pt
Shipbuilding				Energy transitio	No impact	Logistics and supply chain	High Impact																						Pt
Shipbuilding				Maritime decarb	Low Impact																								Pt
Shipbuilding	Condition-based	Maintenance	Reliability Engineer	Digital	High Impact	Data and analytics manag	High Impact	High-level education	Universities	Continuing	2 years	Not adequate		x	x	x		x	x	x	x	x	x	x	x	x	x	x	Pt
Shipbuilding				Innovation	Low Impact	Logistics and supply chain	High Impact																						Pt
Shipbuilding				Energy transitio	No impact																								Pt
Shipbuilding				Maritime decarb	Low Impact																								Pt
Shipbuilding	Energy efficient	Conception & Design	Naval architects	Digital	No impact	Decarbonization	High Impact	High-level education	Universities	Continuing	2 years	Not adequate	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	Pt
Shipbuilding				Innovation	High Impact	Navigation	High Impact																						Pt
Shipbuilding				Energy transitio	Low Impact	Energy Management	Low Impact																						Pt
Shipbuilding				Maritime decarb	High Impact																								Pt
Offshore energy	Offshore Wind Farm	Operations & Maintenance	Offshore wind farm	Digital	No impact	Logistics and supply chain	High Impact	Post-secondary (EQF level 5)	Vocational training centres	Apprenticeship	2 years	Not adequate	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Pt
Offshore energy				Innovation	Low Impact	Skills related to the energy	High Impact																						Pt
Offshore energy				Energy transitio	High Impact																								Pt
Offshore energy				Maritime decarb	High Impact																								Pt
Offshore energy	Offshore Wind Farm	Operations & Maintenance	Maintenance Manager	Digital	Low Impact	Energy Management	High Impact	High-level education	Universities	Continuing	2 years	Not adequate	x	x	x	x			x	x	x	x	x	x	x	x	x	x	Pt
Offshore energy				Innovation	Low Impact	Data and analytics manag	High Impact																						Pt
Offshore energy				Energy transitio	High Impact	Skills related to the energy	High Impact																						Pt
Offshore energy				Maritime decarb	High Impact																								Pt

APPENDIX II

Basque country

Mechanical, electrical and hydraulic systems
Energy efficiency & green tech integration
Sensor technology and data management for predictive maintenance.
Electrical, propulsion and control systems
Expertise in subsea systems and operations,
Design of electrical systems for power transmission and control
Automation systems
Environmental impact assessments and mitigation strategies
Technological component & equipment
Artificial intelligence for predictive maintenance and decision making
Environmental expertise (regulations and sustainable practices)
Structures and processes
Energy Efficiency & Energy Management System / Integration of green technologies
Big Data, Sensor data, Data Analytics for predictive maintenance
Big data and data analytics for fleet management and operations optimization
Design of turbines, generators, and other mechanical components
3D modeling, printing and simulation,
Life Cycle Assessment (LCA) expertise for designing sustainable vessels
Propulsion systems (e.g electric, hybrid, hydrogen fuel cells, sail-powered)
Development of Safe and environmentally friendly decommissioning techniques.
Surface treatment
Condition-based monitoring systems and predictive maintenance strategies
Cybersecurity expertise for secure on-board data management

Ireland

Offshore Wind Farm Maintenance
Cybersecurity expertise for secure on-board data management
Shipboard Waste Management
Ecological footprint of ships
Artificial intelligence for predictive maintenance and decision making
Operate underwater vehicles to inspect offshore installations
Sensor technology and data management for predictive maintenance.
Route optimization to reduce fuel consumption and emissions.
Intelligent navigation systems: autonomy of ships, sensors, navigation instruments, dynamic positioning, electronics...

France

Artificial Intelligence (AI), virtual and augmented reality
3D modeling, printing and simulation,
Internet of Things (IoT) -based solutions
Automation systems
Energy Efficiency & Energy Management System / Integration of green technologies
Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps,..)
Design the foundations and support structures for offshore wind farms and other renewable energy installations
Design of turbines, generators, and other mechanical components
Sensor technology and data management for predictive maintenance.
Drones, ROV and autonomous vehicles
Big data and data analytics for fleet management and operations optimization
Cybersecurity expertise for secure on-board data management
Artificial intelligence for predictive maintenance and decision making
Ecological footprint of ships

Portugal

Alternative Fuels (e.g., hydrogen, ammonia, batteries, pumps,..)
Big data and data analytics for fleet management and operations optimization
Design the foundations and support structures for offshore wind farms and other renewable energy installations
Human-centered design
Automation systems
Offshore Wind Farm Maintenance
Big Data, Sensor data, Data Analytics for predictive maintenance,
Artificial Intelligence (AI), virtual and augmented reality
Composites materials
Life Cycle Assessment (LCA) expertise for designing sustainable vessels
Propulsion systems (e.g electric, hybrid, hydrogen fuel cells, sail-powered)
Cybersecurity expertise for secure on-board data management
Artificial intelligence for predictive maintenance and decision making
Intelligent navigation systems: autonomy of ships, sensors, navigation instruments, dynamic positioning, electronics...
Expertise in subsea systems and operations,
Sensor technology and data management for predictive maintenance.
Operate underwater vehicles to inspect offshore installations
Environmental expertise (regulations and sustainable practices)
Condition-based monitoring systems and predictive maintenance strategies
Energy efficient vessel design