Offshore wind skills

RESEARCH INSIGHTS & INDUSTRY PERSPECTIVE

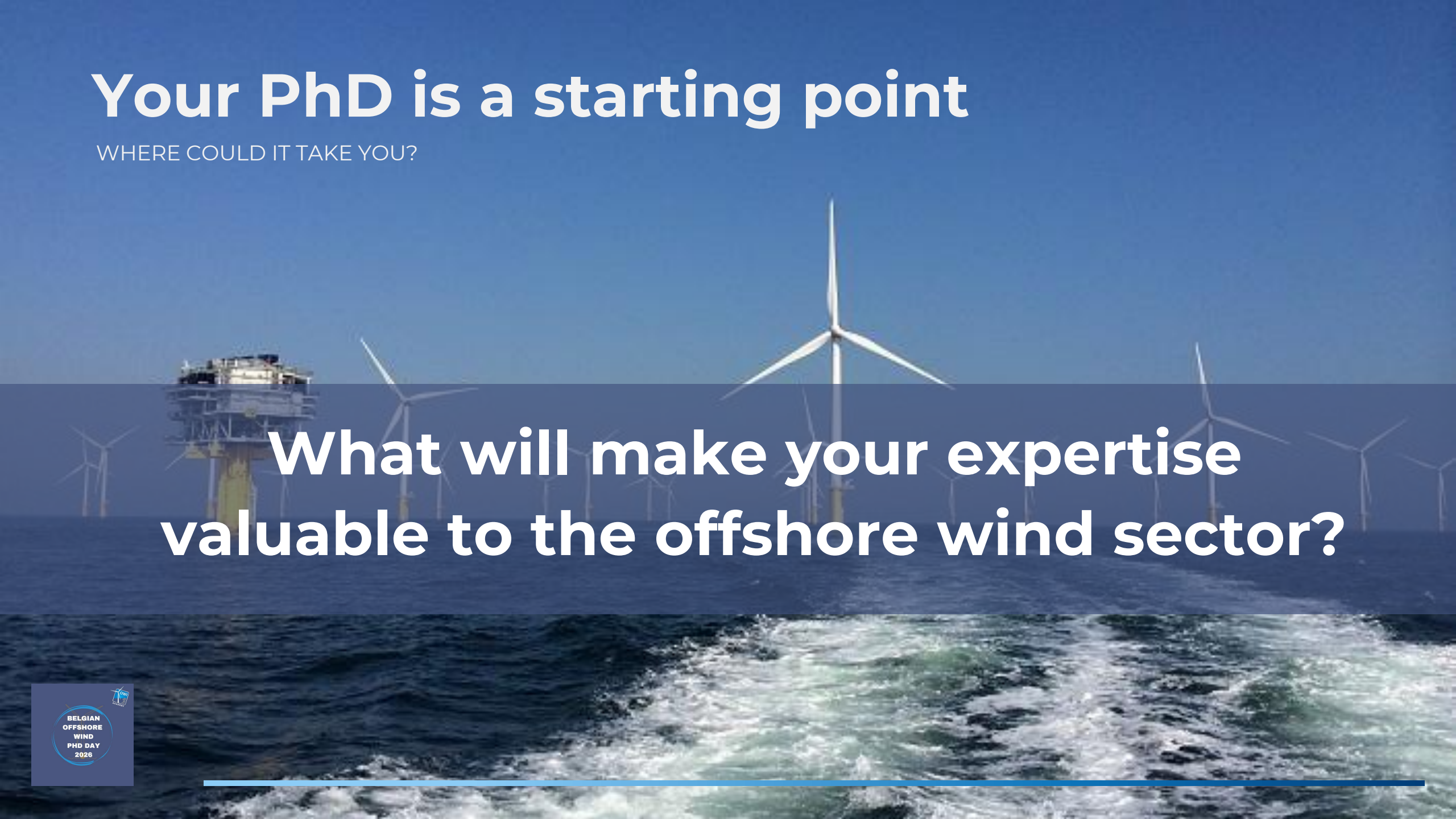


Setting the scene

PART 1

Your PhD is a starting point

WHERE COULD IT TAKE YOU?

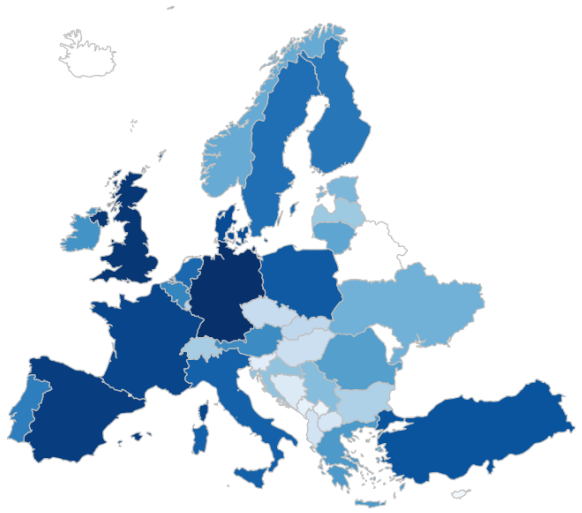


What will make your expertise valuable to the offshore wind sector?

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Europe’s challenge

BUILDING THE WORKFORCE TO DELIVER ITS WIND AMBITIONS



2025 FTE

2025 JOBS BY PHASE



55,600 FTE
110,000 FTE
15,300 FTE
34,500 FTE
9,650 FTE

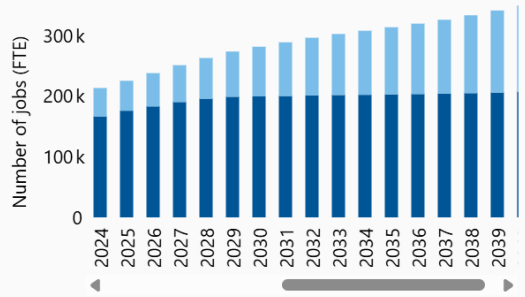
2025 JOBS (FTE)

		ONSHORE	OFFSHORE
DIRECT JOBS	225,000	175,000	49,200
INDIRECT JOBS	253,000	208,000	45,500
TOTAL	478,000	383,000	94,700

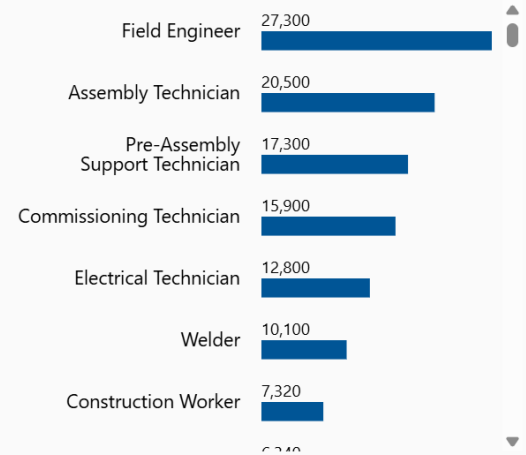
2030 JOBS (FTE)

		ONSHORE	OFFSHORE
DIRECT JOBS	280,000	200,000	82,000
INDIRECT JOBS	310,000	230,000	76,000
TOTAL	590,000	430,000	160,000

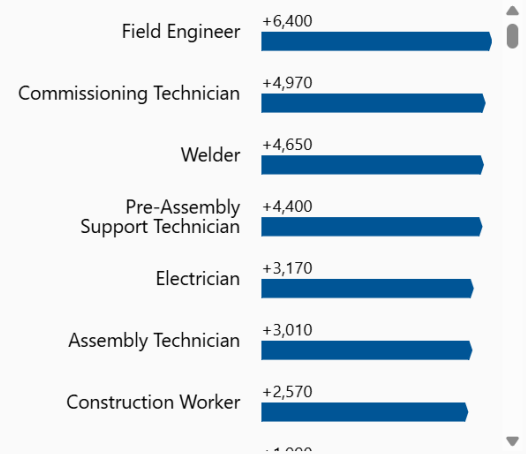
EMPLOYMENT EVOLUTION



2025 JOBS



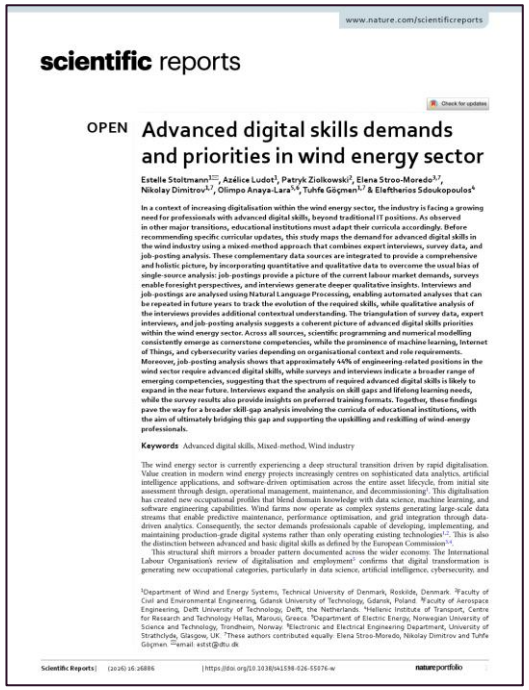
2025-30 GROWTH



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OPEN Advanced digital skills demands and priorities in wind energy sector

Estelle Stoltmann[1✉], Azélice Ludot[1], Patryk Ziolkowski[2], Elena Stroo-Moredo[3,7], Nikolay Dimitrov[4,7], Olimpo Anaya-Lara[5,6], Tuhfe Göçmen[4,7] & Eleftherios Sdoukopoulos[4]

In a context of increasing digitalisation within the wind energy sector, the industry is facing a growing need for professionals with advanced digital skills, beyond traditional IT positions. As observed in other major transitions, educational institutions must adapt their curricula accordingly. Before recommending specific curricular updates, this study maps the demand for advanced digital skills in the wind industry using a mixed-method approach that combines expert interviews, survey data, and job-posting analysis. These complementary data sources are integrated to provide a comprehensive and holistic picture, by incorporating quantitative and qualitative data to overcome the usual bias of single-source analysis: job-postings provide a picture of the current labour market demands, surveys enable foresight perspectives, and interviews generate deeper qualitative insights. Interviews and job-postings are analysed using Natural Language Processing, enabling automated analyses that can be repeated in future years to track the evolution of the required skills, while qualitative analysis of the interviews provides additional contextual understanding. The triangulation of survey data, expert interviews, and job-posting analysis suggests a coherent picture of advanced digital skills priorities within the wind energy sector. Across all sources, scientific programming and numerical modelling consistently emerge as cornerstone competencies, while the prominence of machine learning, Internet of Things, and cybersecurity varies depending on organisational context and role requirements. Moreover, job-posting analysis shows that approximately 44% of engineering-related positions in the wind sector require advanced digital skills, while surveys and interviews indicate a broader range of emerging competencies, suggesting that the spectrum of required advanced digital skills is likely to expand in the near future. Interviews expand the analysis on skill gaps and lifelong learning needs, while the survey results also provide insights on preferred training formats. Together, these findings pave the way for a broader skill-gap analysis involving the curricula of educational institutions, with the aim of ultimately bridging this gap and supporting the upskilling and reskilling of wind-energy professionals.

Keywords Advanced digital skills, Mixed-method, Wind industry

The wind energy sector is currently experiencing a deep structural transition driven by rapid digitalisation. Value creation in modern wind energy projects increasingly centres on sophisticated data analytics, artificial intelligence applications, and software-driven optimisation across the entire asset lifecycle, from initial site assessment through design, operational management, maintenance, and decommissioning[1]. This digitalisation has created new occupational profiles that blend domain knowledge with data science, machine learning, and software engineering capabilities. Wind farms now operate as complex systems generating large-scale data streams that enable predictive maintenance, performance optimisation, and grid integration through data-driven analytics. Consequently, the sector demands professionals capable of developing, implementing, and maintaining production-grade digital systems rather than only operating existing technologies[1,2]. This is also the distinction between advanced and basic digital skills as defined by the European Commission[3,4].

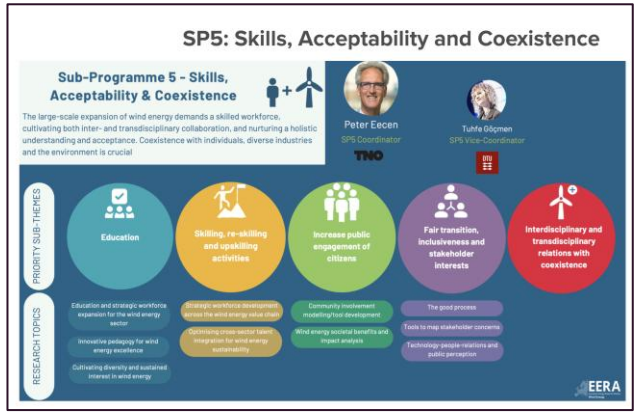
This structural shift mirrors a broader pattern documented across the wider economy. The International Labour Organisation’s review of digitalisation and employment[5] confirms that digital transformation is generating new occupational categories, particularly in data science, artificial intelligence, cybersecurity, and

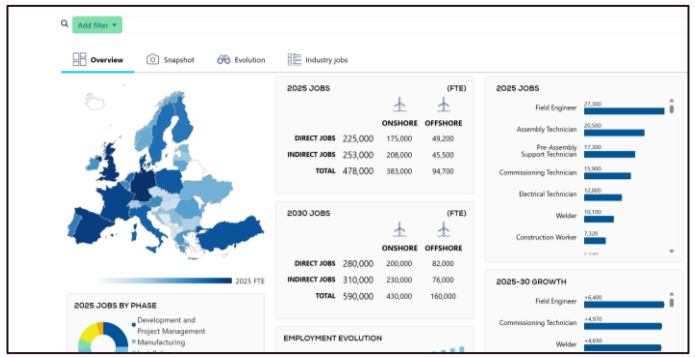
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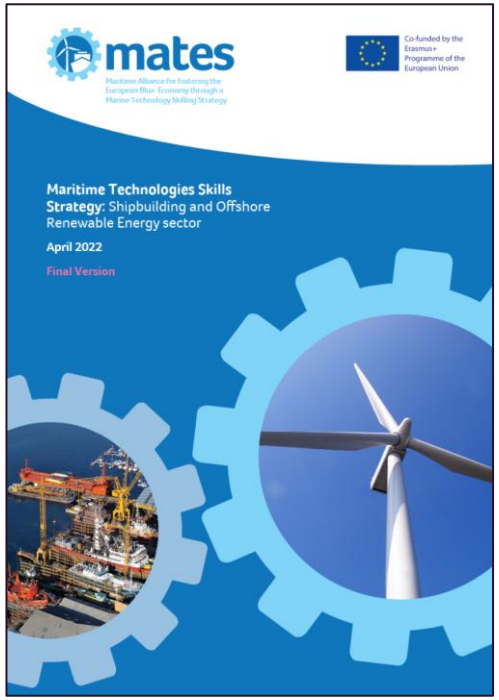
Scientific Reports | (2026) 16:26886 | https://doi.org/10.1038/s41598-026-55076-w nature portfolio







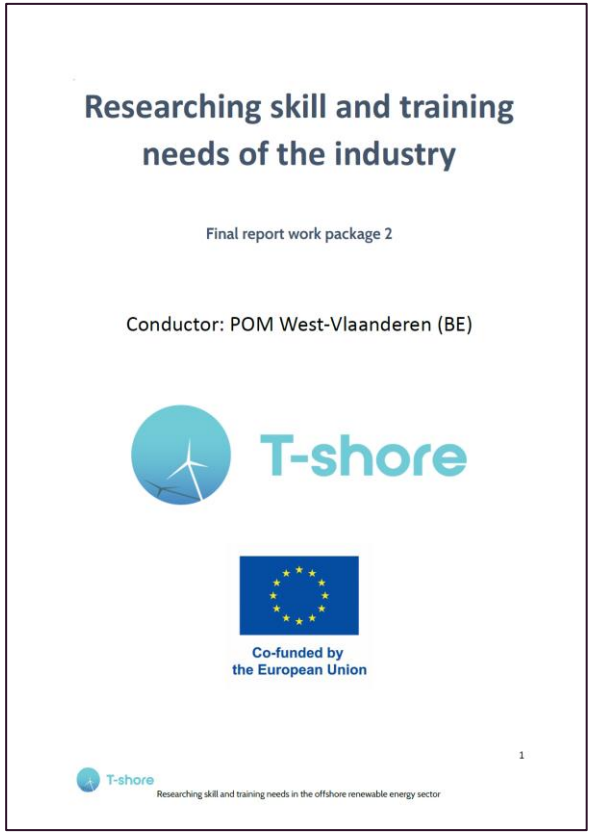


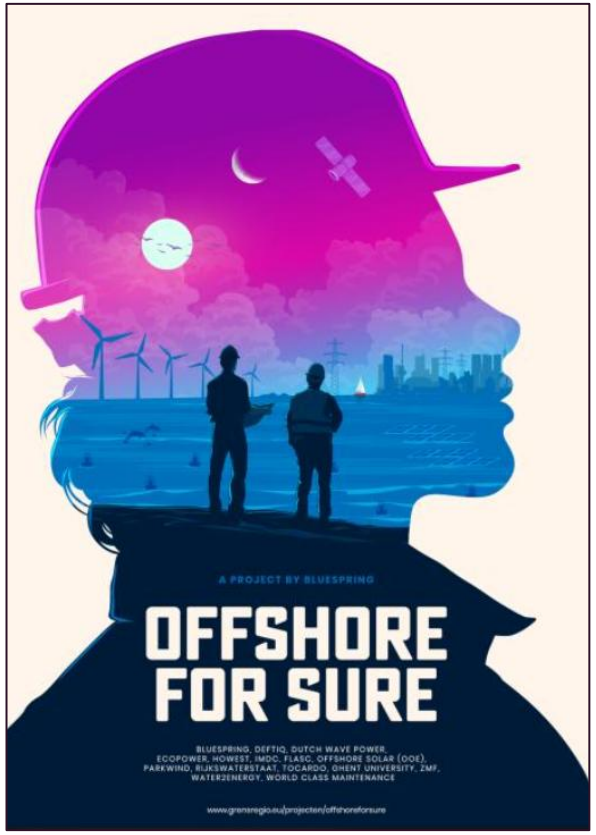


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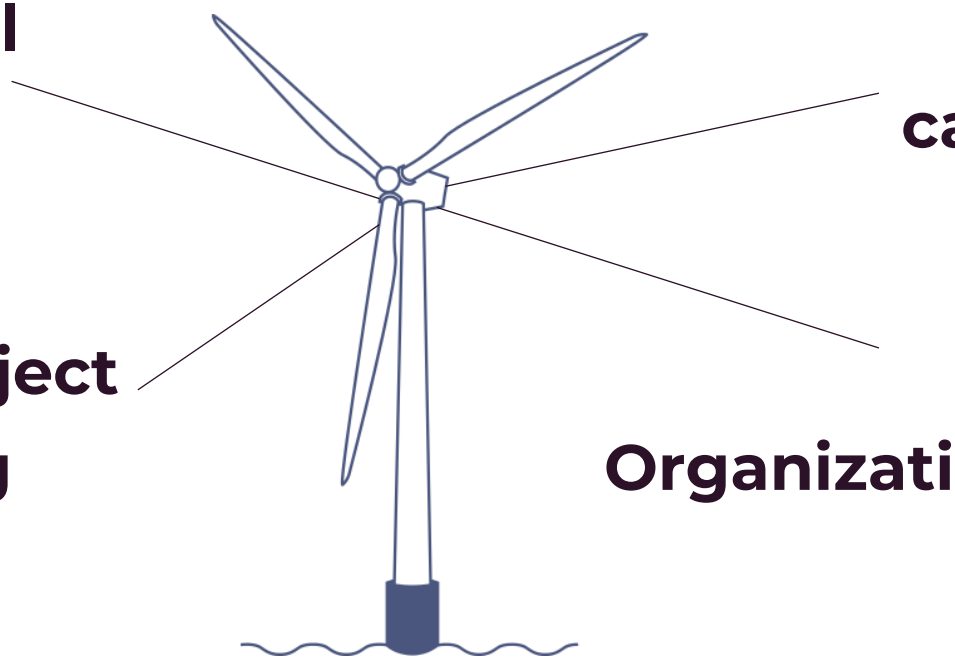
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The winning profile: depth + breadth

FOUR RECURRING DIMENSIONS FROM THE STUDIES

1 **Deep technical expertise**

2 **Digital capabilities**



3 **Systems & project understanding**

4 **Human & Organizational skills**

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Skills inventory

PART 2

Technical skills

THE CORE EXPERTISE OFFSHORE WIND NEEDS

1 Mechanical, structural and offshore engineering

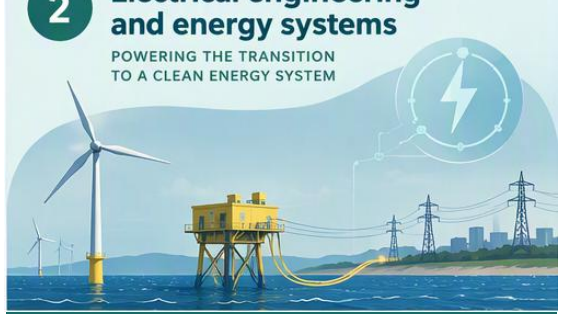
DESIGNING ROBUST SOLUTIONS FOR A SUSTAINABLE OCEAN FUTURE



- Structural mechanics
- Fatigue & fracture analysis
- Turbine design
- Drivetrains
- Offshore foundations
- Fixed & floating wind
- Hydrodynamics
- Marine operations
- Installation engineering

2 Electrical engineering and energy systems

POWERING THE TRANSITION TO A CLEAN ENERGY SYSTEM



- Power systems
- Grid integration
- High-voltage systems
- Offshore substations
- Protection & control
- Power electronics
- Energy storage
- Energy-system modelling

3 Manufacturing, materials and industrial engineering

FROM INNOVATIVE MATERIALS TO A RESILIENT SUPPLY CHAIN



- Materials science
- Manufacturing processes
- Production optimization
- Quality assurance
- Industrial engineering
- Composite materials
- Supply-chain processes
- Circular design

4 Reliability, operations and maintenance

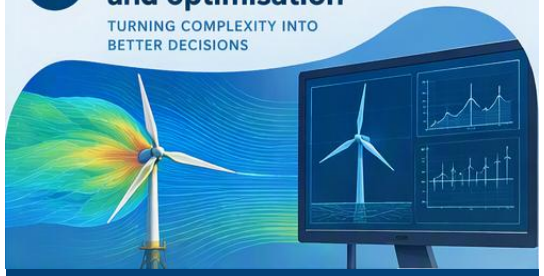
MAXIMISING PERFORMANCE THROUGH DATA AND EXPERTISE



- Reliability engineering
- Asset management
- Condition monitoring
- Failure analysis
- Maintenance planning
- Inspection technologies
- Lifetime extension
- Performance optimisation

5 Modelling, simulation and optimisation

TURNING COMPLEXITY INTO BETTER DECISIONS



- CFD
- Aeroelastic modelling
- Wake modelling
- Structural simulation
- Digital Twins
- Numerical methods
- Energy-yield calculations
- Optimisation
- Control Systems

6 Environmental and sustainability expertise

A THRIVING OCEAN FOR GENERATIONS TO COME



- Environmental impact ass.
- Biodiversity monitoring
- Marine ecosystem knowledge
- Nature-inclusive design
- LCA
- Circular economy
- Recycling
- Decommissioning
- Repowering

Digital skills

INCREASINGLY RELEVANT ACROSS SPECIALISATIONS

Research focused

Research, modelling & advanced analytics

Scientific programming: Phython, MATLAB, ...

Software development, Git, version control

Reproducible research & maintainable code

Statistics, data analytics & time-series analysis

Artificial intelligence & machine learning

Numerical modelling, simulation & optimization

Data engineering, data pipelines & cloud computing

Operational

Operational & digital infrastructure

SCADA systems & operational dashboards

IoT, sensor technologies & instrumentation

Remote monitoring & diagnostics

Condition monitoring & predictive maintenance

Digital asset management & maintenance workflows

Industrial data management & data security

Cybersecurity for connected systems & critical infra

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Non-technical skills

THE MULTIPLIER MOST RESEARCHERS UNDERESTIMATE

1 COMMUNICATION

- Scientific writing
- Presentations
- Technical reporting
- Explaining complexity to non-experts
- Stakeholder communication
- Intercultural communication

2 COLLABORATION & TEAMWORK

- Interdisciplinary teamwork
- Knowledge sharing
- Industry-academia collaboration
- Networking
- International cooperation
- Conflict management

3 PROJECT MANAGEMENT

- Planning & priorisation
- Time management
- Risk management
- Resource allocation
- Coordinating work packages
- Budget & deadline management

4 LEADERSHIP

- Taking initiative
- Decision-making
- Mentoring
- Coaching
- Responsibility
- Change management
- Inclusive team leadership

5 THINKING & PROBLEM SOLVING

- Critical thinking
- Analytic thinking
- Creative thinking
- Systems thinking
- Problem-solving
- Evaluating evidence & uncertainty

6 ADAPTABILITY & LEARNING

- Lifelong learning
- Self-directed learning
- Learning agility
- Flexibility
- Openness to feedback
- Adapting expertise to new technologies and sectors

7 STAKEHOLDER & BUSINESS AWARENESS

- Stakeholder engagement
- Negotiation
- Understanding industrial needs
- Commercial awareness
- Costs & value chains
- Policy & regulatory awareness

8 INNOVATION & ENTREPRENEURSHIP

- Initiative
- Experimentation
- Learning from failure
- Innovation mindset
- Product thinking
- Translating research into implementation
- Entrepreneurial awareness

Connecting all skills

WHICH SKILLS REQUIRED AT WHICH STAGE?



Scientific expertise ● Programming ● Modelling ● Experimentation ● Analytic thinking

Real-world data ● Testing ● Reliability ● Documentation ● Critical thinking ● Quality assurance

Teamwork ● Project management ● User engagement ● Communication ● Cost awareness ● Operational understanding

Emerging competences

WHAT COULD GIVE YOU AN ADVANTAGE?

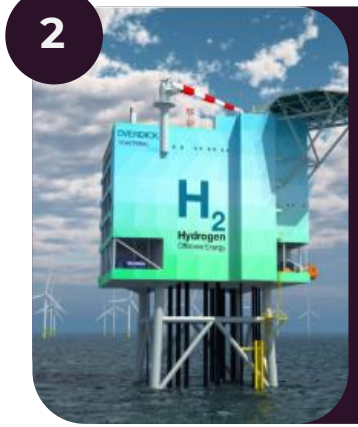
1



AI-enabled & autonomous offshore operations

AI-assisted inspection · Autonomous drones & unmanned vessels · Underwater robotics · Robotic inspection and maintenance · Computer vision · Remote and autonomous operations

2



Connected, data-driven energy infrastructure

Floating wind · Offshore hydrogen integration · Energy storage · Smart grids · Cross-technology systems modelling · Integration with other marine renewables

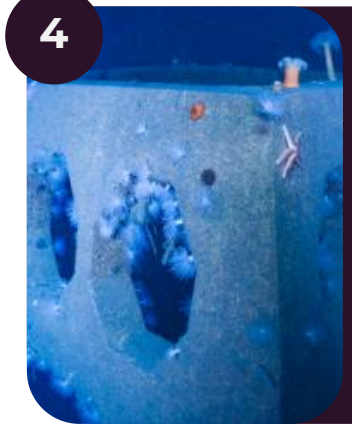
3



New offshore technologies & integrated energy systems

Digital twins · AI-based predictive maintenance · Edge & cloud computing · Cybersecurity · Secure data sharing · Smart sensors · Advanced condition monitoring

4



Sustainable & resilient offshore development

Nature-inclusive design · Biodiversity data & monitoring · Circular materials · Blade recycling · Decommissioning & repowering · Climate & infrastructure resilience · Co-existence with fisheries/marine users · Social acceptance & stakeholder engagement

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Belgian situation

PART 3

Numbers for Belgium

BUT WITH A BIG GRAIN OF SALT...



2025 FTE

2025 JOBS BY PHASE



1,200 FTE
1,310 FTE
141 FTE
648 FTE
15 FTE

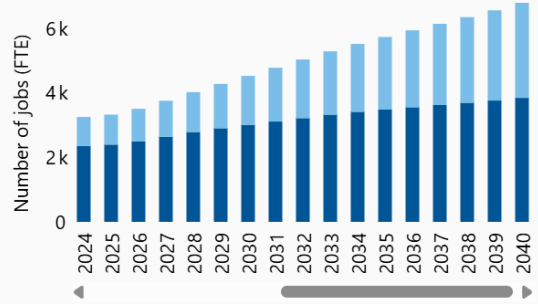
2025 JOBS (FTE)

		ONSHORE	OFFSHORE
DIRECT JOBS	3,310	2,390	925
INDIRECT JOBS	3,580	2,560	1,020
TOTAL	6,890	4,950	1,950

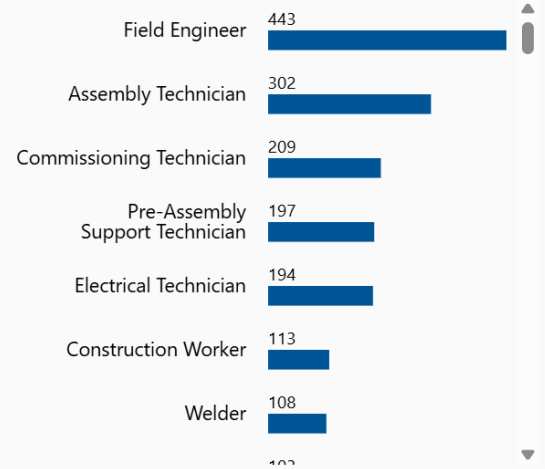
2030 JOBS (FTE)

		ONSHORE	OFFSHORE
DIRECT JOBS	4,500	3,000	1,500
INDIRECT JOBS	4,900	3,200	1,700
TOTAL	9,400	6,200	3,200

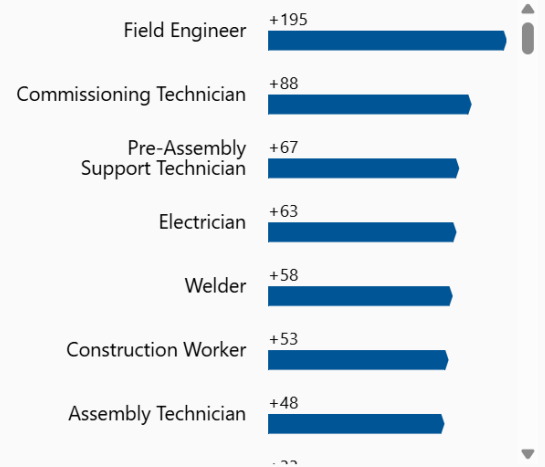
EMPLOYMENT EVOLUTION



2025 JOBS



2025-30 GROWTH



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Belgian reports add practical detail

SKILLS FOR REAL-WORLD OFFSHORE OPERATIONS



Project management

A recurring priority across the Belgian reports & an identified training gap



Digitalisation

From advanced research methods to digital tools used in daily operations



Human & collaborative skills

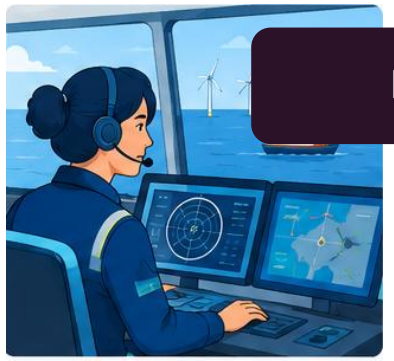
Technical knowledge is more effective when combined with the ability to work across disciplines

Offshore wind needs people who combine deep technical expertise with project, digital and interpersonal skills

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Belgian specifics

WHAT DOES THE BELGIAN EVIDENCE MAKE MORE CONCRETE?



North Sea operations

- Marine coordinators
- Control-room operators
- Logistics coordination



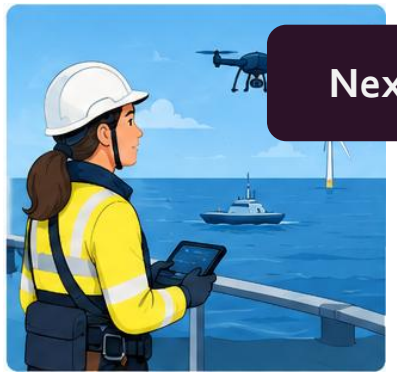
Digital skills in operation

- SCADA & dashboards
- Remote diagnostics
- Condition monitoring & digital maintenance workflows



Multidisciplinary technicians

- Mechanical
- Electrical
- Electronic
- Hydraulic



Next generation offshore work

- Drones & underwater robotics
- Autonomous vessels
- Cybersecurity
- Nature-inclusive design

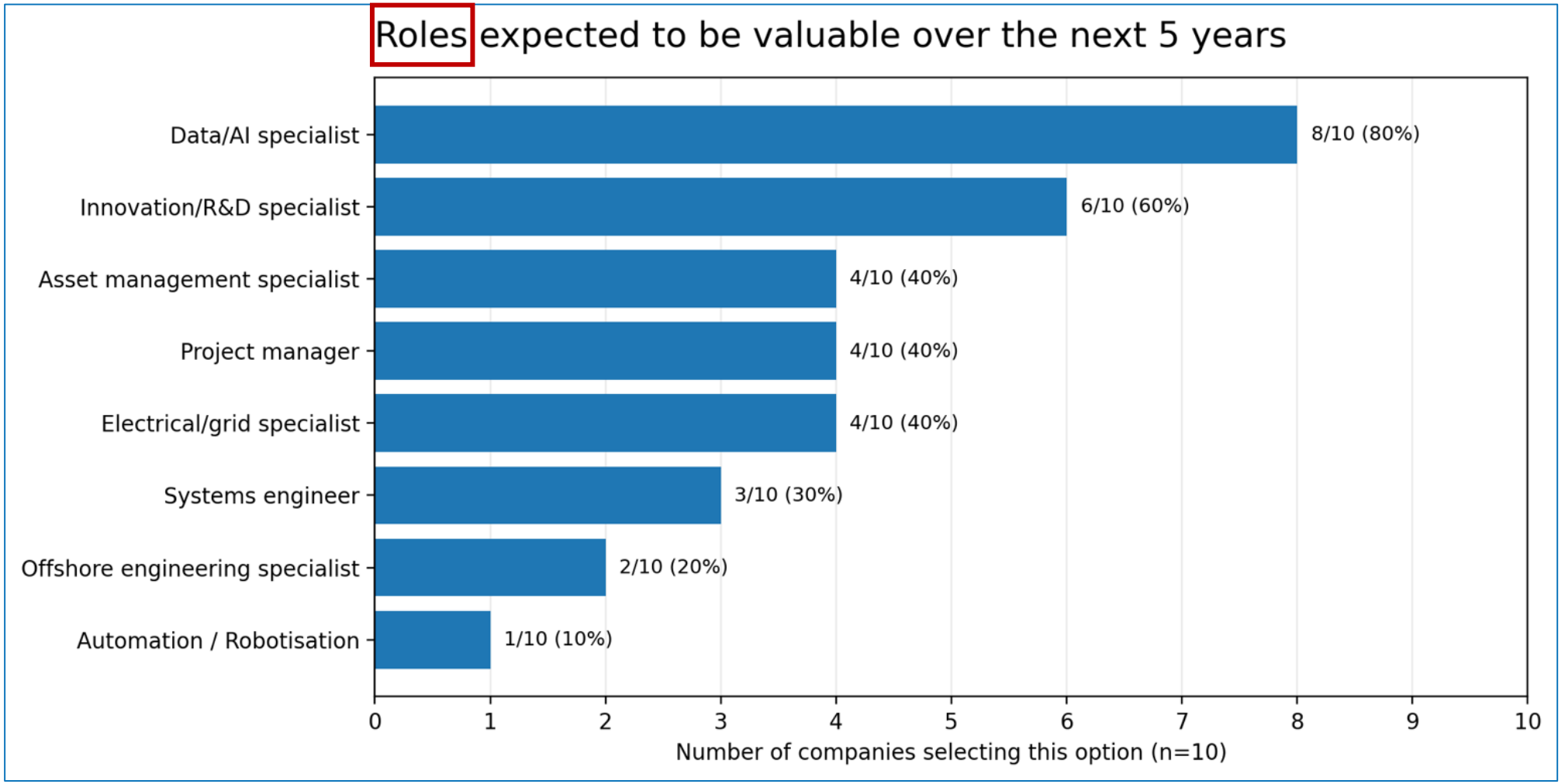
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Results from the OWI-Lab IAB

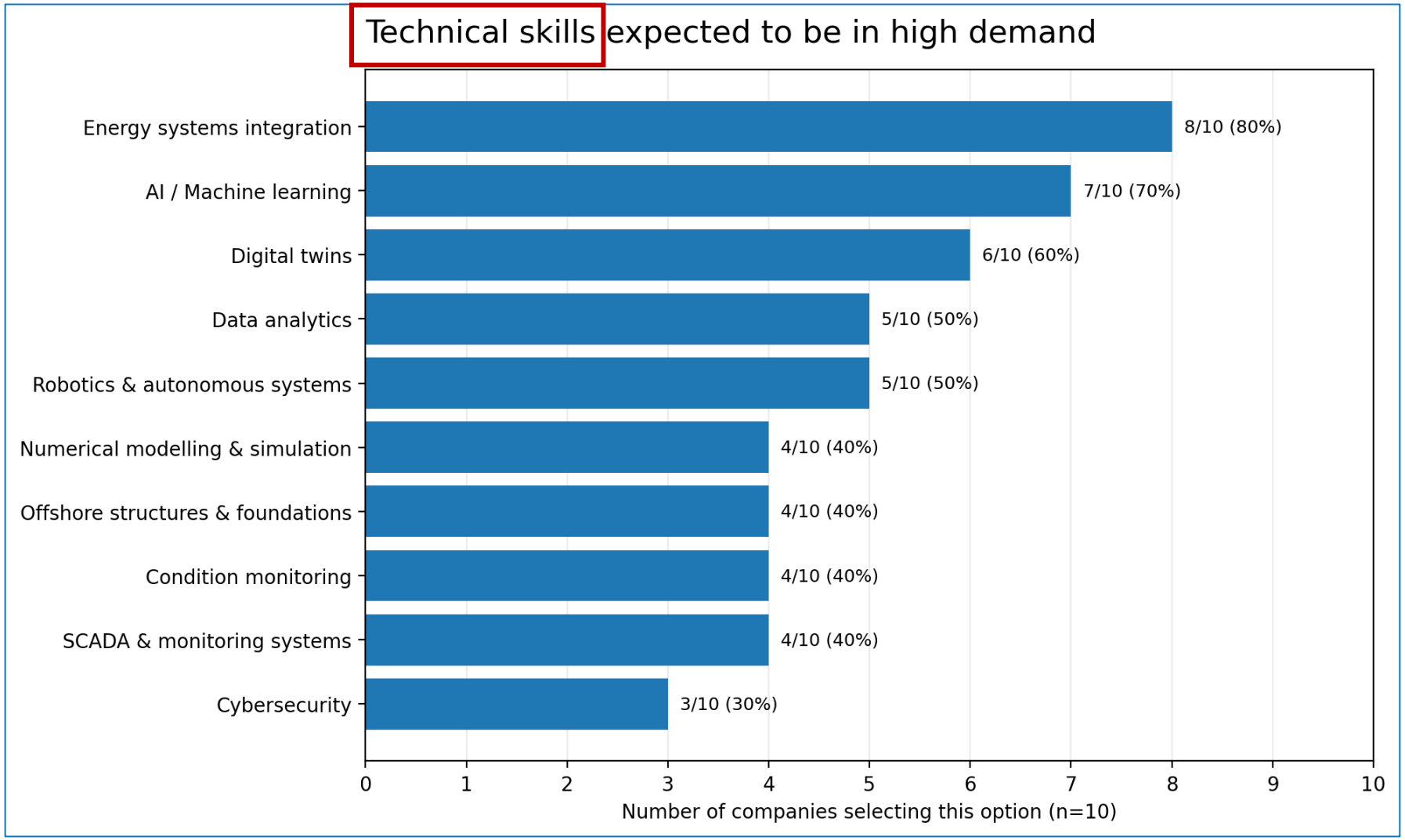
SMALL SURVEY BETWEEN BELGIAN CAPTAINS OF INDUSTRY

- 10 Belgian companies responded: DEME, JERA Nex BP, Smulders Group, Fluves, ENGIE Laborelec, Bekaert, Sirris, ZF Wind Power, C-Power, Smulders Projects (OEM)

- Conclusions:
  - Digital skills are becoming core offshore wind skills
  - Biggest gap is not technical knowledge, but applying that knowledge in an industrial context
  - Industry wants researchers who take initiative & turn research into practical value

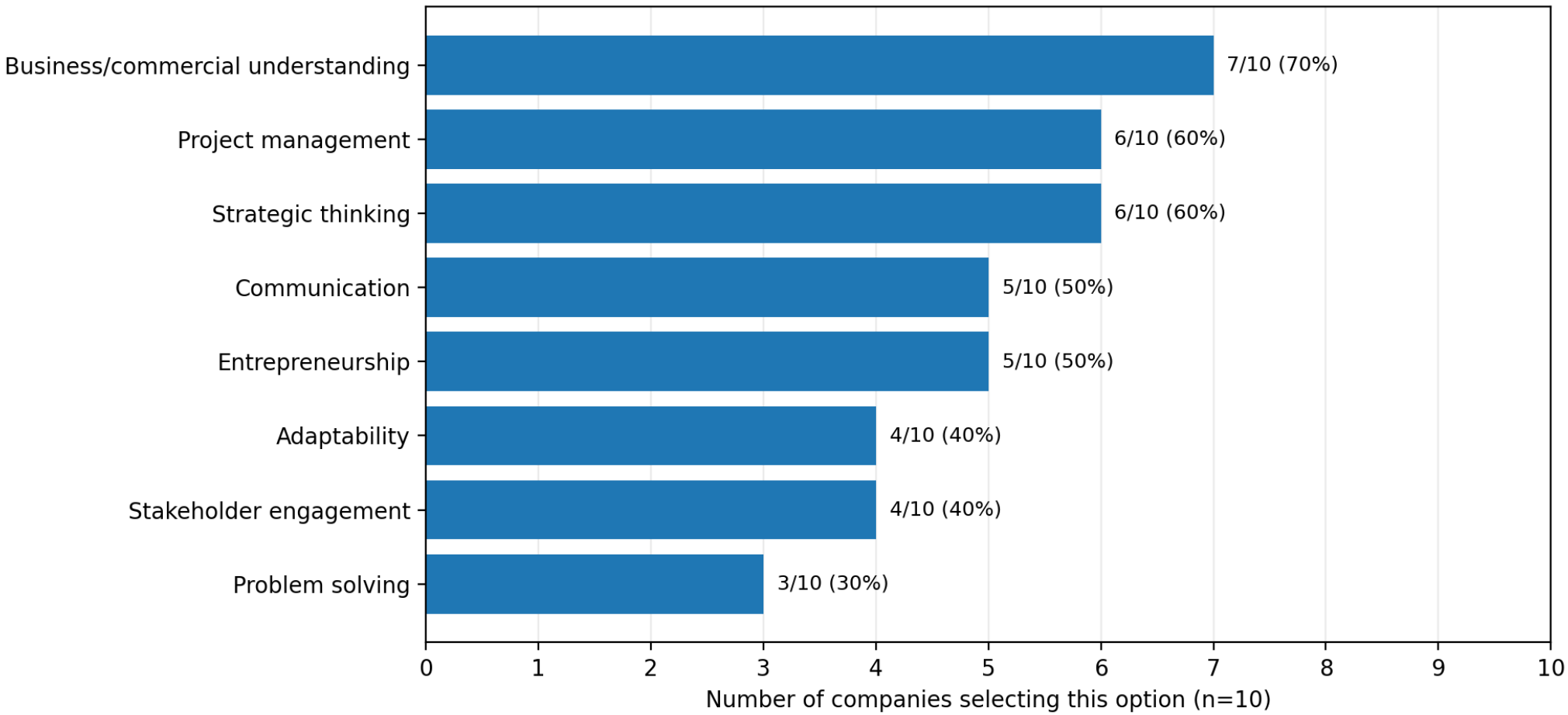


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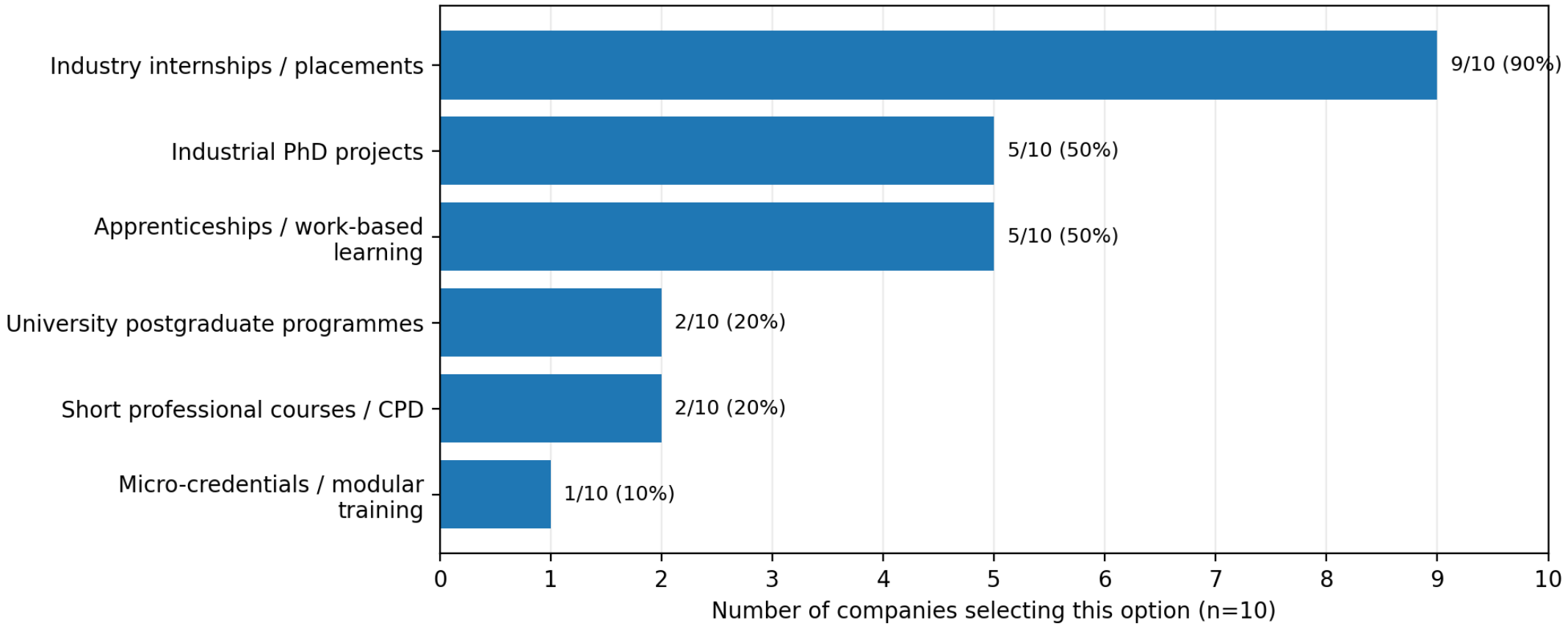
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Non-technical skills most lacking among young researchers

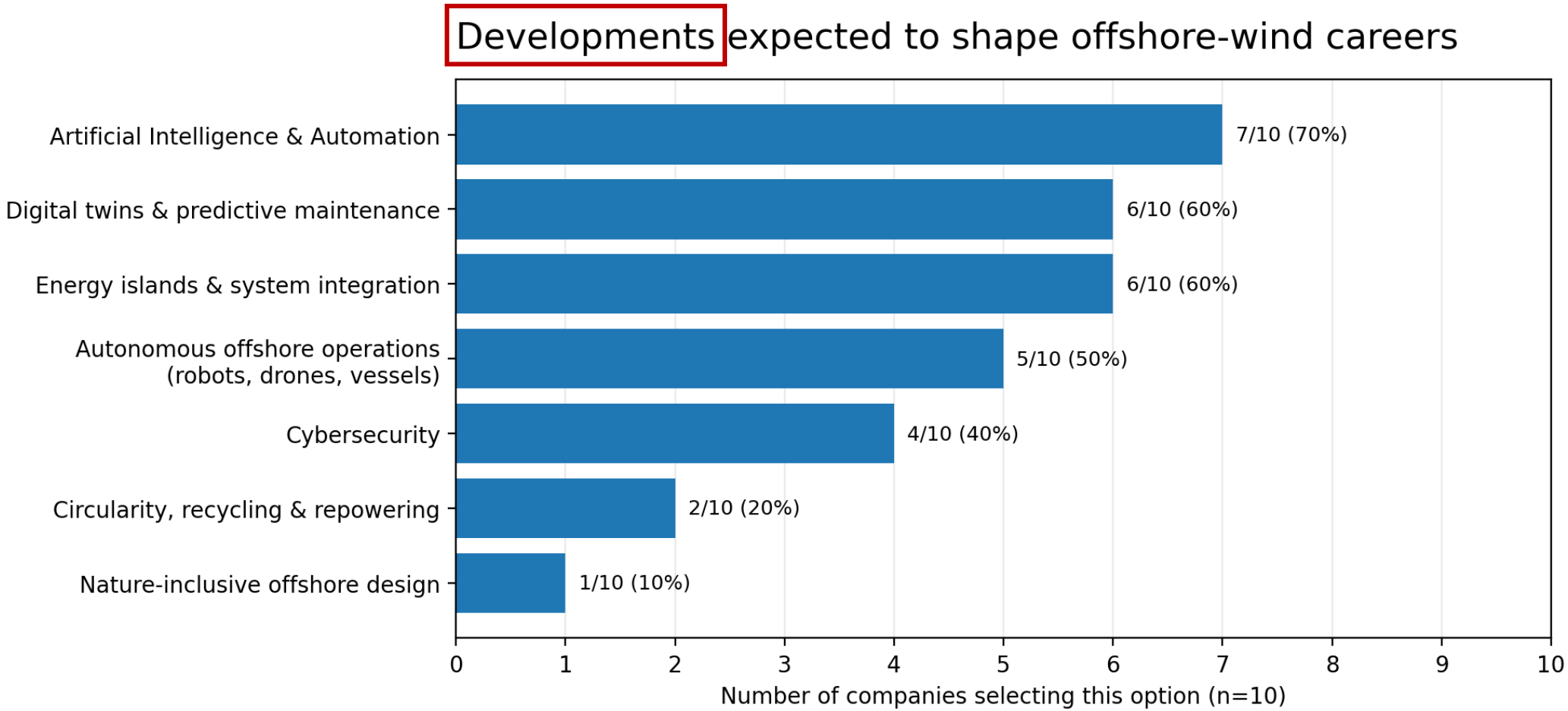


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Training formats considered most valuable

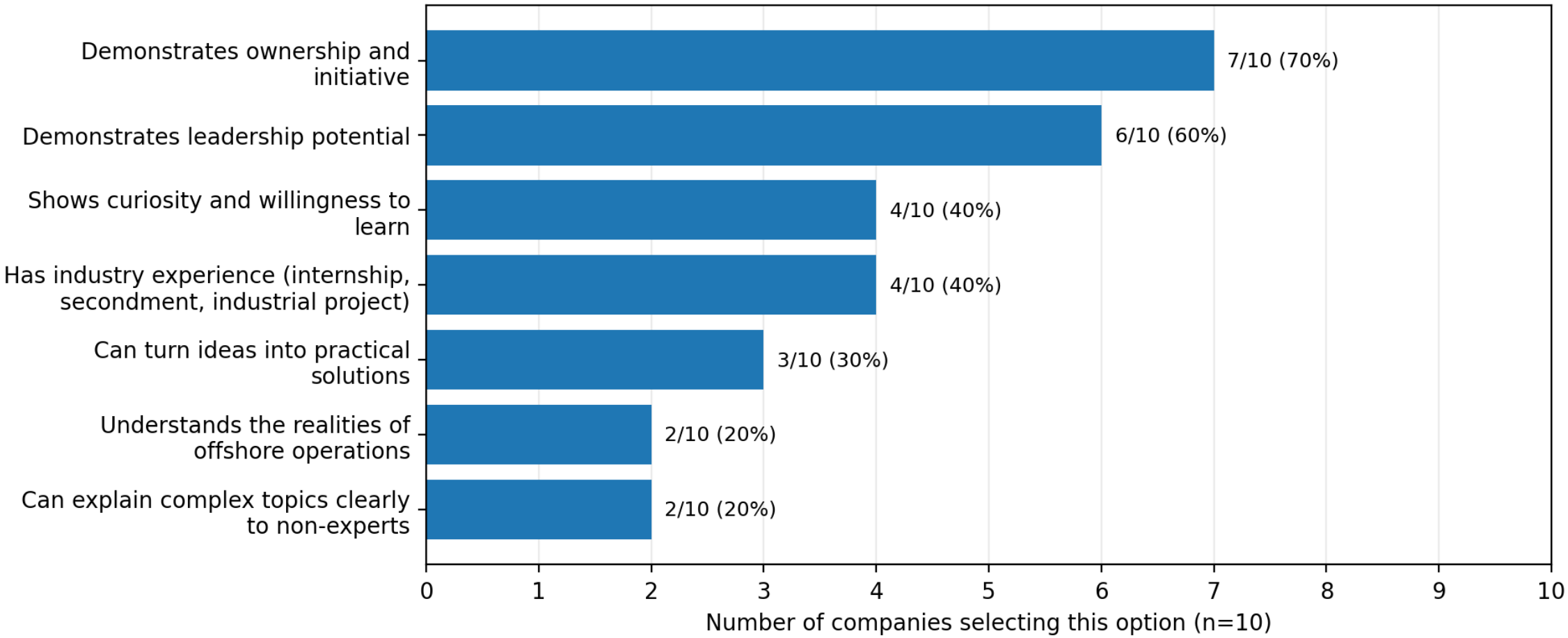


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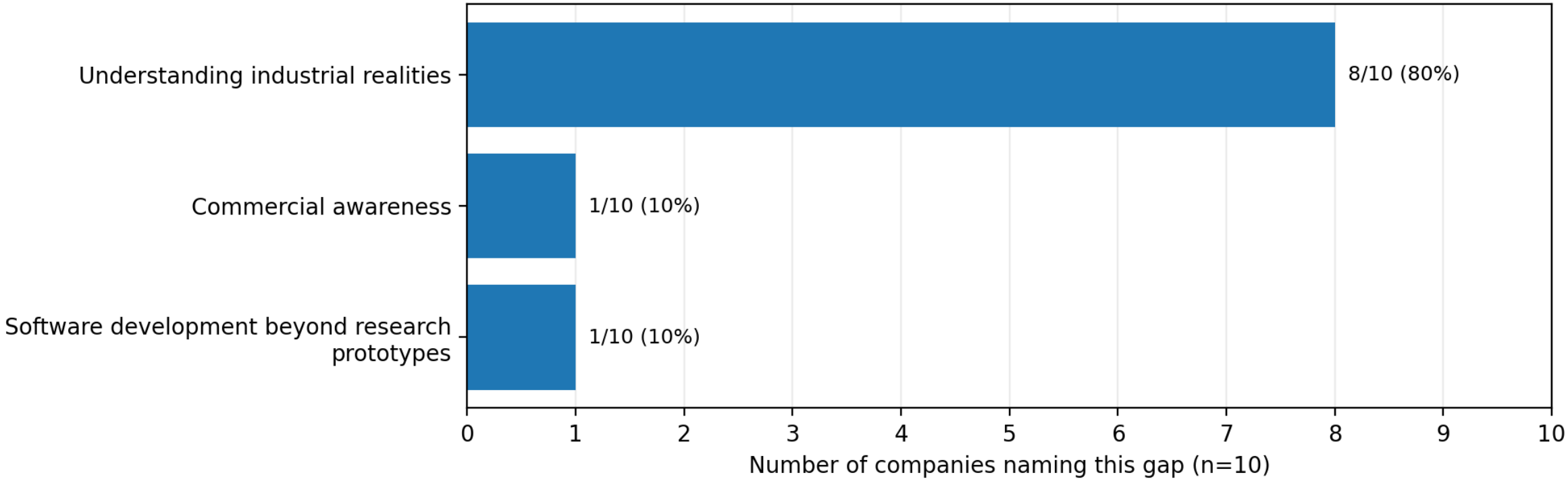


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What makes a PhD graduate stand out?



Largest gap between PhD training and industry needs



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And some final words of advice

WHAT GENERAL ADVICE WOULD YOU GIVE A PHD STUDENT WHO WANTS TO WORK IN OFFSHORE WIND?

“More than 90% of wind energy is still onshore. Think about topics that are common to onshore and offshore wind if you are passionate about wind energy.”

“Connect to the industry during your PhD already (internships, visits, networking, events, …)”

“Try building a local (Belgium) network surrounding BE experts but also business developers and other non-engineering profiles. Understand the macro-economic & geopolitical context of offshore wind. Energy = Politics nowadays.”

“Define first the added value/business proposition linked to the idea prior to continue spending time and effort on research + stay connected with the "customer" of your research activity. Focus should in this market be high on reducing cost while keeping reliability high.”

“Dive into the practice”

Conclusions

PART 4

Your PhD is your edge. Make it matter

OFFSHORE WIND NEEDS SPECIALISTS WHO CAN CONNECT KNOWLEDGE TO REAL-WORLD IMPACT



Go deep

Build distinctive technical expertise in your field



Connect the dots

Develop digital, project & interdisciplinary skills, incl. communication, teamwork & leadership



Think beyond the research

Understand the people, operations & systems that turn knowledge into solutions

You don’t need every skill!

Know your strengths, spot your gaps & build those skills that make your expertise more useful

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