Powering the Future

Global Offshore Wind Workforce Outlook

2020-2024

GLOBAL WIND ORGANISATION

GWEC
GLOBAL WIND ENERGY COUNCIL

Definitions

Terms	Definition
Basic Safety Training	GWO training standard consisting of five training modules and regarded as the minimum necessary to enter or work on an offshore wind project
GRIP	Global Renewable Infrastructure Projects database, developed by The Renewables Consulting Group and containing data on offshore wind projects worldwide, from concept stage through to operations and maintenance
GW	Gigawatts
GWEC	Global Wind Energy Council
GWEC Data	An annual forecast of projected offshore wind installations in 94 target countries for the period 2020 to 2030
GWO	Global Wind Organisation
GWO Data	A dataset extracted from the WINDA Database listing all GWO Sea Survival and Sea Survival Refresher training courses undertaken at all European training centres from its launch in October 2016 to January 2020
MW	Megawatts
O&M	Operations and Maintenance – phase of the offshore wind project lifecycle following commissioning
RCG	The Renewables Consulting Group Ltd
Reference Period	The calendar years 2017-2019 (inclusive) for which full GWO data is available and which was the subject of the analysis in this report. Note: Excludes available data from 2016 and 2020 to allow for data to be analysed on a 'whole year' basis
Sea Survival	A component module of the GWO Basic Safety Training course, usually a pre-requisite for working offshore on projects developed by GWO member organisations, and a proxy for calculating the size of the workforce qualified to work offshore
Sea Survival Refresher	A refresher course for the Sea Survival course, required every two years to ensure ongoing competence
Target markets	Six key emerging markets of interest to GWO and GWEC and the focus of the 'look ahead' elements of this report: North America, China, Taiwan, Japan, Vietnam and South Korea
WINDA	GWO database for recording all GWO training undertaken and the details of all training recipients
WINDA ID	Unique identifier assigned to each GWO training recipient, as recorded in WINDA
Workforce Requirement	An estimate of the size of the workforce required to construct and/or operate (depending on context) a specified offshore wind generating capacity
WTG(s)	Wind turbine generator(s)

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Foreword

Ben Backwell, CEO, Global Wind Energy Council

"Building a safe, knowledgeable and global workforce means that we will be able to build the energy systems of tomorrow by unlocking the full potential that offshore wind has to offer."

There is no question that offshore wind will be a key driver of the global energy transition over the next three decades. With mature markets established in Europe and a developed supply chain, this burgeoning industry is now entering new markets across the globe and is set to become a $1 trillion industry by 2030, according to the IEA.

The industry has grown nearly 30% per year between 2010 and 2019. At GWEC, we expect this growth to accelerate sharply over the coming years as the world races to completely decarbonise its power sector in line with the requirements set out by the IPCC. With 29.1GW of offshore capacity already installed at the end of 2019, GWEC Market Intelligence expects 50GW of new installations by 2024, by which time offshore will constitute around 20% of total new wind installations across the world.

However, as we head towards 2050, the deployment will need to accelerate still further. European policy makers are looking to installations of 450GW, while the rest of the world - and in particular Asia - will need to deploy as much as 500GW.

As the offshore wind sector plays an increasingly important role in energy systems across the globe and our level of ambition rises, it is absolutely crucial that we have the workforce in place to back up these ambitions and successfully implement policy.

Ensuring that we have a workforce with sufficient levels of skill in safety, technical and other essential training to power offshore wind development worldwide is essential to secure healthy long-term growth and the necessary degree of sustainability of the sector. This is especially important in the emerging markets highlighted in this report, as they are looking both to move fast to emulate the European experience and deploy offshore wind power at competitive prices, and to develop their own local supply chains to support this booming industry.

Manufacturing, installing and operating mega-size offshore wind turbines is a challenging line of work; therefore health and safety must be priorities to nurture and care for our human resources, attract talent and build a good reputation for the industry.

Ensuring that the right training and standards are in place as the market continues to grow to new parts of the world is necessary to establish a safe working environment and retain a workforce for years to come.

Getting this right is not only important to accelerate the energy transition globally, but will also be an important driver of local job creation and investment for these emerging markets.

This landmark report produced by GWO and GWEC is an important tool to build a coherent roadmap for offshore wind jobs, assessing where a growing workforce will need to be deployed in order to meet demand and outlining what training is required to create this workforce.

Through GWEC's collaboration with GWO, we are able to paint a full picture of what the growth of the offshore wind industry means both at a macro and micro level.

This will start to allow us to align global market trends to local demand and workforce requirements, and to individual training needs in order to better understand what needs to be done in order to continue accelerating offshore wind across the globe.

Building a safe, knowledgeable and global workforce means that we will be able to build the energy systems of tomorrow by unlocking the full potential that offshore wind has to offer.

We look forward to working with you all to develop this work further as the industry moves to realise this opportunity.

Foreword

Jakob Lau Holst, CEO, Global Wind Organisation

GLOBAL WIND ORGANISATION

"Our intention is to provide a means of forecasting workforce training demand for GWO standard training because this is often the missing link when developers, turbine manufacturers and contractors consider a new project."

A global industry needs, wherever possible, to apply global standards. The six new and future offshore wind markets identified in this report are set to develop over 30GW of capacity by 2024. Offshore wind is on the verge of true globalization and by the middle of the next decade it will count on a workforce in the tens of thousands to install, commission and service turbines safely in often very hazardous conditions.

We invested in this research with our partners at Global Wind Energy Council to help support vital workforce development and ensure standards become available for all employers.

GWO is a nonprofit formed by globally leading wind turbine manufacturers and owner-operators who collaborated and published the first Basic Safety Training (BST) standard in 2012. The objective is to strive towards an injury-free working environment for wind technicians globally. Our standards aim to improve quality of safety training, increase safety for wind technicians, while allowing duty-holders better control for all workers on a site, reducing time and cost dedicated to safety training.

As a result of mutual recognition of GWO training by our members, and a strong governance around training delivery, hundreds of independent training providers have established and the standard is available close to every port, pre-assembly site or any other wind power installation activity in most first mover offshore wind markets.

Our aim is to help new offshore wind markets reap the same benefits of safety, quality and productivity that standardized workforce training has delivered thus far.

Having spoken to developers, manufacturers and training institutions from locations around the world considering investing in training facilities, one question prevails. How many people will we need to train? We tackle this question in these pages.

GWO hosts over 500,000 training records in the Wind Industry Database (WINDA). By analyzing this dataset in combination with both GWEC's and Renewables Consulting Group's intelligence and market insight, this report offers conclusions about the potential workforce needs in the six leading offshore wind markets outside Europe.

GWO standards are designed for wind turbine technicians. The workforce in scope for this report goes no further than those working on installation, commissioning and service of wind turbines. You will find other reports out there, arriving at larger figures, as they include workforces from the entire offshore wind supply chain. A majority of which are outside of the scope of GWO safety training.

Our intention is to provide a means of forecasting workforce training demand for GWO standard training because this is often the missing link when developers, turbine manufacturers and contractors consider a new project.

To service new and future offshore wind markets, we expect dozens of new GWO certified training providers will open. Already there are certified training providers in China, the USA and Taiwan training or prepared for offshore wind. In the USA, a historic network of private training providers, maritime colleges and unionized labor training programs is looking ready-made, while Gulf Coast oil and gas industry is well placed to adapt workforce training for the unique demands of an offshore wind turbine environment. In Taiwan, impressive university campus facilities have emerged in Kaohsiung City while the joint venture Taiwan International Windpower Training Centre counts Chinese and Taiwanese ports, shipbuilding, steel and turbine manufacturers amongst its investors. In China, GoldWind was first mover in when they opened a state-of-the-art Sea Survival training facility in Jiangsu Province.

This is just the beginning. These regions need a network of training centres many times their current scale to train a workforce of almost 80,000 people.

We are extremely grateful to our partners who helped develop this report. I do hope you find it useful and welcome any feedback you may have.

Chapter 1: Introduction

In 2019, Global Wind Organisation partnered with the Global Wind Energy Council to highlight the importance of safety, training and job creation to power wind energy deployment and the global energy transition.

This report is the first output of our collaboration. We engaged research partners Renewables Consulting Group to deliver a qualitative analysis on workforce training needs in target markets for offshore wind, including North America, China, Taiwan, Japan, Vietnam and South Korea. This analysis aimed to answer the question:

"How much training is required, on a per MW basis, to work on site building the pipeline of offshore wind in the target markets, and how can we address any workforce supply chain bottlenecks?"

In seeking answers to this question, researchers utilised GWO training data and an offshore wind installation forecast compiled by GWEC. These datasets were analysed and subsequently augmented by data from Renewables Consulting Group's GRIP database and publicly available data from industry sources, together with more subjective inputs derived from a series of interviews with GWO member organisations and training providers.

The overall data analysis sought to derive a 'persons required per MW' figure for offshore wind installations in Europe over the 2017-19 period based on training data and known installation activity. This baseline figure was then applied to the project pipeline data to arrive at indicative workforce requirements for each of the target markets over the 2020-24 period.

It is important to note that 'installation activity' in this report refers to the entire construction period and all elements of it (including foundation and cable installation), not simply the installation and commissioning of WTGs, which requires a relatively small number of personnel.

Forecast installations are current as of GWEC's Q1 2020 outlook. GWEC takes into account the potential impacts of COVID-19 on the global wind market, but maintains its forecast for this report considering the latest offshore wind developments in China and 2021 deadline ahead of the local industry. Regarding other target markets, the dynamic nature of the pandemic makes it too early to quantify market impacts.

The question of addressing any workforce supply chain bottlenecks was considered through interviews with key GWO member companies and training providers.

Table 1: Forecast installations (in MW) for key markets to 2024 and associated workforce requirements

Market	Forecast installations (MW)	Calculated workforce requirement
North America	5,720	14,300
China (mainland)	19,000	47,500
Taiwan	3,579	8,948
Japan	860	2,150
Vietnam	1,100	2,750
South Korea	560	1,400
Total	**30,819**	**77,048**

The key conclusions from the analysis, as detailed in the remainder of this report, are:

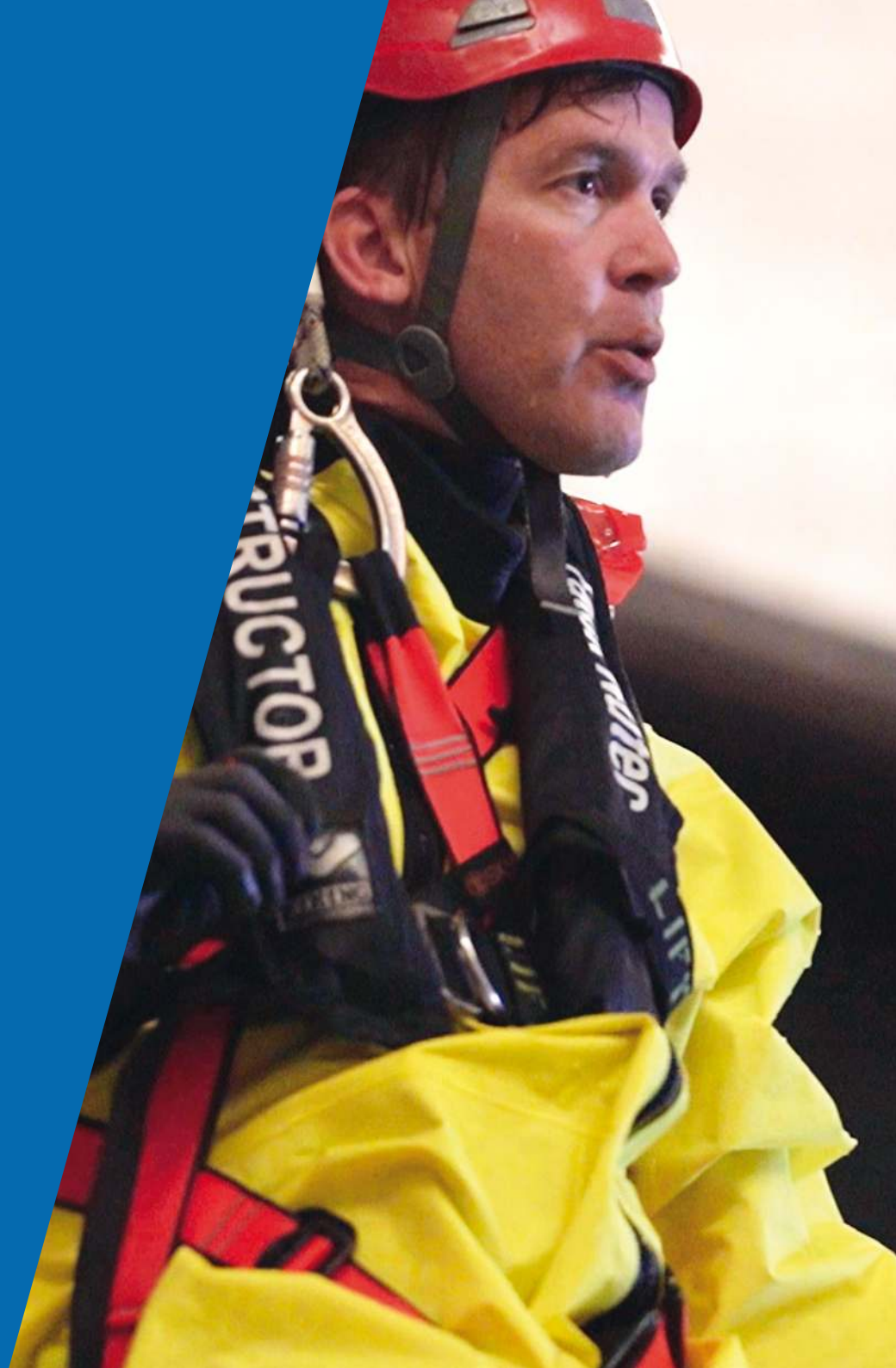
- Offshore wind installation currently requires a GWO-trained workforce of approximately 2.5 persons per MW per project
- A GWO- trained workforce of around 77,000 persons will be required for the projected installations in the six target markets to 2024

The main workforce supply chain bottlenecks are:

- Barriers to establishing GWO training centres, including a lack of available instructors, insufficient numbers of certifying auditors familiar with the standards
- Lack of familiarity overall with standards like GWO
- Risk of standards seen as being "imposed" as opposed to a system that markets can align themselves to reflect local regulation and cultural norms.

Chapter 2: Approach and Methodology

This chapter describes the methodology applied to reach the key conclusions and roadmap set out in this report.



Data Sources

GWO

The GWO data provided uses the Sea Survival and Sea Survival Refresher courses as a proxy for the total number of persons trained to work offshore. It does not consider the other GWO modules that individuals may have completed and therefore does not provide information on the type of work that individuals may be undertaking once offshore.

The data therefore does not distinguish between persons trained in Sea Survival only (for example those undertaking visits to the wind farm site but not transferring off the transfer vessel) and those who have completed the full suite of basic safety training modules, such as construction personnel and wind turbine maintenance technicians.

It also does not include those who may be a critical component of the workforce but engaged solely in onshore work such as substation construction or onshore cable laying.

Conversely, the data does not provide evidence of any person who has undergone sea survival, or other GWO training modules, but subsequently not worked offshore.

The dataset does not therefore consider redundancy and may over-estimate the size of the workforce without further analysis.

The data, as provided, includes details of all Sea Survival and Sea Survival Refresher courses completed and uploaded to the GWO WINDA database from its launch date in October 2016 to a cut-off in January 2020. The data included the date on which the course was completed, the name and location of the training provider and the home country attached to each individual's WINDA ID.

GWEC

The GWEC data provided is a forecast of new offshore wind installations (in MW) in 94 markets (including each target market) for each year up to and including 2030.

Researchers supplemented this with data covering the reference period from RCG's proprietary GRIP database (to understand the number of projects in operation and the relative sizes of the European markets) and publicly available data published by WindEurope (for the total installed capacity and turbines at the end of the reference period).

Data Analysis

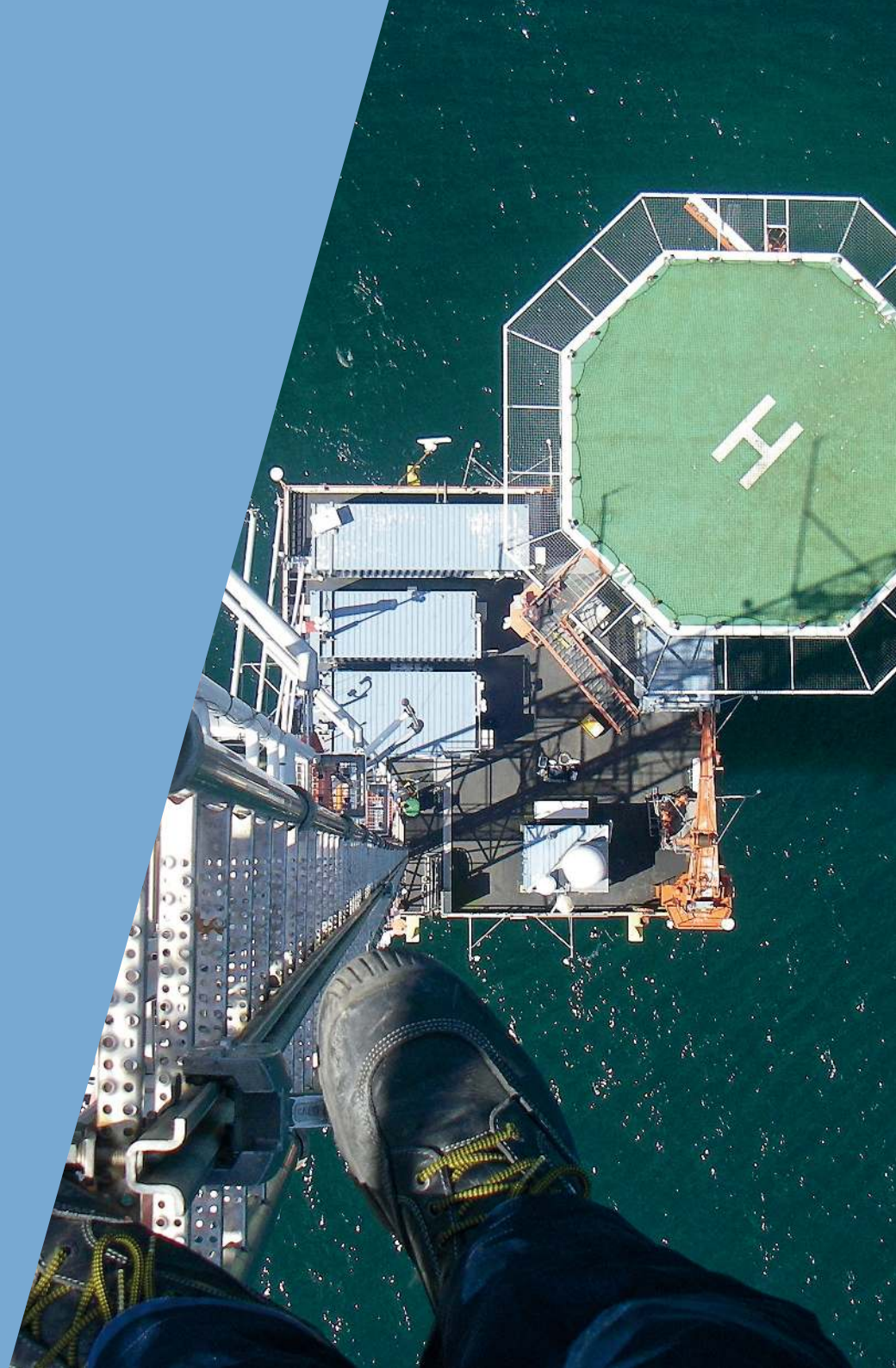
The results presented in Chapter 3 Part 1 are based primarily on simple filtering and pivot table analysis of the training data extracted from the WINDA database. Where required, this data was supplemented by data from the RCG GRIP database, specifically in relation to market activity (the MW of projects in operation or in construction during the reference period).

The calculations are based on a more complex analysis of the GWO data to establish the size of the workforce. Supplemented by RCG project data, WindEurope installations data and industry knowledge to estimate a baseline 'persons per MW' figure.

The baseline figure was applied to the GWEC forecasts in a simple multiplication.

Chapter 3: Data Analysis and Commentary

Workforce training data and market growth forecast analysis, used to identify a person/MW correlation.



Part 1:
How many people during the reference period have completed GWO Sea Survival training?

Training delivered by market

Table 2 lists the total number of Sea Survival and Sea Survival Refresher modules completed in each of the countries listed, during the reference period. Figure 1 and Figure 2 show the same data graphically.

Table 3 shows the number of training modules completed and indicative offshore wind capacity in each European market, both expressed as a percentage of the total. Figure 3 shows the same data graphically. The capacity data is extracted from the RCG GRIP database and refers to the capacity of all offshore wind farms commissioned or under construction at the end of 2019. This is used as an approximate measure of the 'size' of the industry for the purposes of Part 1. A more detailed analysis is provided in Part 2 of this chapter.

Table 2: Training modules delivered in each European market during the reference period

Market	Sea Survival	Sea Survival Refresher	Total	% of total
United Kingdom	9,222	3,766	12,988	38
Germany	4,543	2,190	6,733	19
Denmark	3,284	1,846	5,130	15
Netherlands	3,065	573	3,638	11
Poland	1,332	355	1,687	5
Belgium	1,086	555	1,641	5
Baltic States[1]	1,094	413	1,507	4
Other[2]	1,095	207	1,302	4
Total	**24,721**	**9,905**	**34,626**	**-**

[1] Estonia, Latvia, Lithuania
[2] The remaining European markets: France, Sweden, Portugal, Spain, Romania, Italy, Ireland

Figure 1: Graphical representation of the training delivered in each European market during the reference period

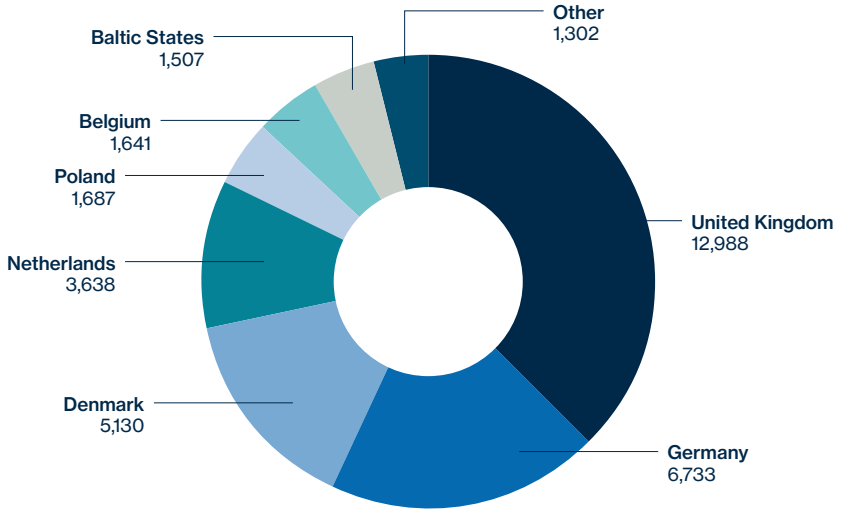


Figure 2: Map depicting the distribution of training delivered across Europe during the reference period

Table 3: Training modules delivered in the reference period and capacity installed or under construction (at end of 2019) in each European market

Market	Total Training Modules	% of total	Capacity[3] (MW)	% of total
United Kingdom	12,988	38	12,237	46
Germany	6,733	19	7,670	29
Denmark	5,130	15	1,701	6
Netherlands	3,638	11	2,601	10
Poland	1,687	5	0	0
Belgium	1,641	5	2,261	8
Baltic States	1,507	4	0	0
Other	1,302	4	249	1
Total	**34,626**	**-**	**26,719**	**-**

Figure 3: Graphical representation of training completed compared with capacity installed or under construction (at end of 2019) in each European market

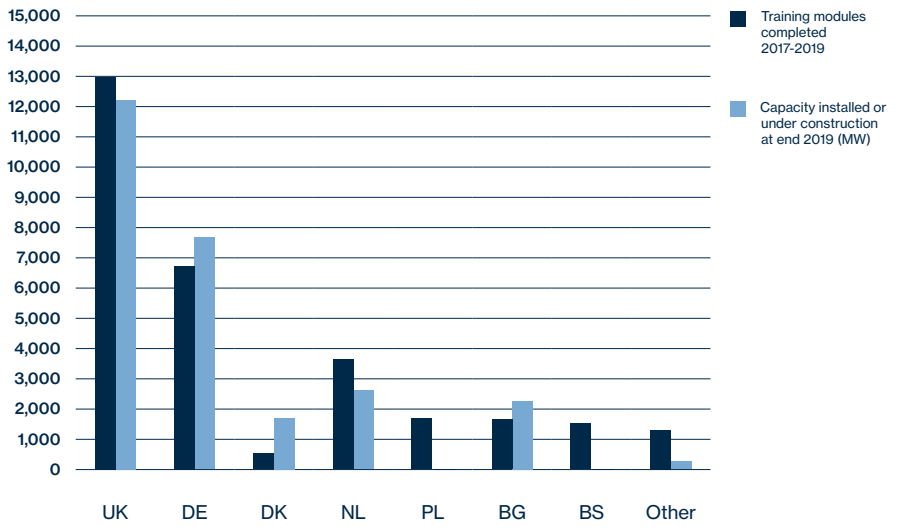


Figure 3: Key Points

- The United Kingdom was by far the largest market for GWO courses, accounting for 38% of all courses completed
- Germany, Denmark and the Netherlands are the next largest markets and each account for over 10% of courses completed
- The data broadly correlates with the size of the offshore wind sector in each of these markets. Key markets for GWO training are clustered around the North Sea, the focus area of the European offshore wind sector
- A significant number of courses were completed in Poland and the Baltic States where there are currently no offshore wind farms under construction or in operation. This may be due, in part, to the lower costs of courses in these markets. However, detailed analysis suggests that candidates completing training in these markets are nationals or residents in those countries. Poland and the Baltic States are therefore exporters of trained personnel to the north-west European markets
- Conversely, fewer training modules were completed in the United Kingdom and Germany relative to the size of their offshore wind sectors (measured by total operational capacity plus projects currently under construction)[4]
- The United Kingdom, Germany, The Netherlands and Belgium appear to require personnel trained in other markets to provide a sufficient workforce for their installation activity, with the deficit provided by Poland, the Baltic States and Denmark. A total of 117 countries and territories are represented in the dataset
- The 'Other' European markets continue to account for very low percentages of the training completed and installed capacity, both individually and collectively
- The higher than expected figures for training completed in Denmark and Spain may be due to the presence of

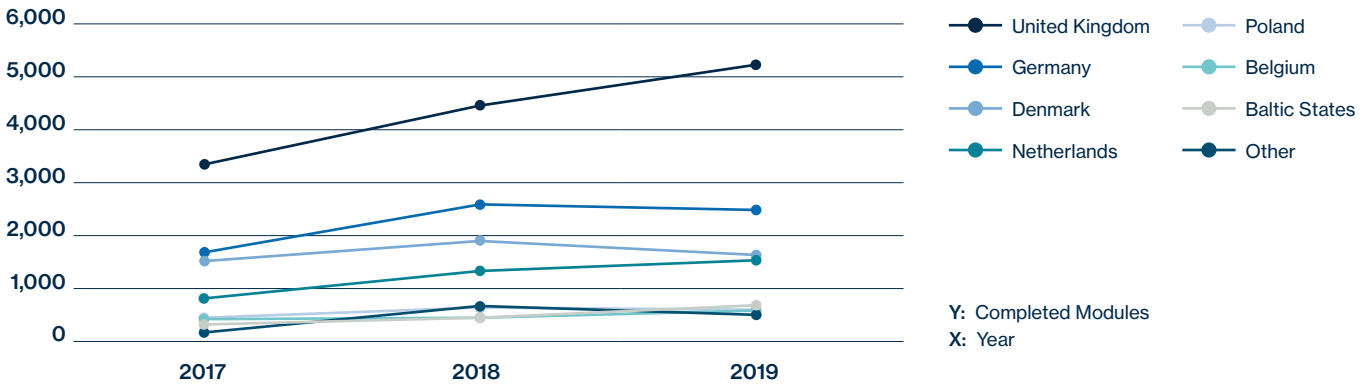
[3] Data from RCG GRIP database. Uses values for end of 2019 as a proxy for industry size and to allow for approximate comparison
[4] The figures used are a 'snapshot' of capacity at the end of 2019 to allow a broad comparison of training activity versus market size. A more detailed analysis is provided in Part 2

Table 4: Training modules delivered in each European market in each year of the reference period

Market	2017	2018		2019		Total
United Kingdom	3,425	4,425	▲ 29%	5,138	▲ 16%	12,988
Germany	1,742	2,542	▲ 46%	2,449	▼ -4%	6,733
Denmark	1,609	1,917	▲ 19%	1,604	▼ -16%	5,130
Netherlands	873	1,282	▲ 47%	1,483	▲ 16%	3,638
Poland	361	709	▲ 96%	617	▼ -13%	1,687
Belgium	360	573	▲ 59%	708	▲ 24%	1,641
Baltic States	263	544	▲ 107%	700	▲ 29%	1,507
Other	128	681	▲ 432%	493	▼ -28%	1,302
Total	**8,761**	**12,673**		**13,192**		**34,626**

Percentage changes are against the previous year

Figure 5: Change in GWO training delivered in each European market over the reference period



large turbine manufacturing facilities here and, in the case of Spain, efforts to develop floating offshore wind

- Detailed analysis (not presented here) suggests that candidates tend to undertake training in their home countries with the notable exception of The Netherlands.

Changes over time

Table 4 lists the total number of training modules (Sea Survival and Sea Survival Refresher) completed in each of the three years of the reference period. Figure 4 and Figure 5 show the same data graphically.

Figure 5: Key Points

- There was a 51% increase in the number of training modules completed between 2017 and 2019

- The rate of increased slowed between 2018 and 2019, with an annual increase of only 3%, suggesting the amount of training (and therefore the size of the workforce) was beginning to stabilise. Data for 2020 will be critical in understanding if this trend continues, or if new entrants in 2018 seek refresher training and remain in the workforce to support the large pipeline of planned projects

- Training intensity increased in all European markets in 2018 but declined in some markets (Germany, Denmark and Poland) in 2019. This may be indicative of slowing construction activity or a

Figure 6: Graphical representation of the training delivered in each quarter of the reference period (both modules)

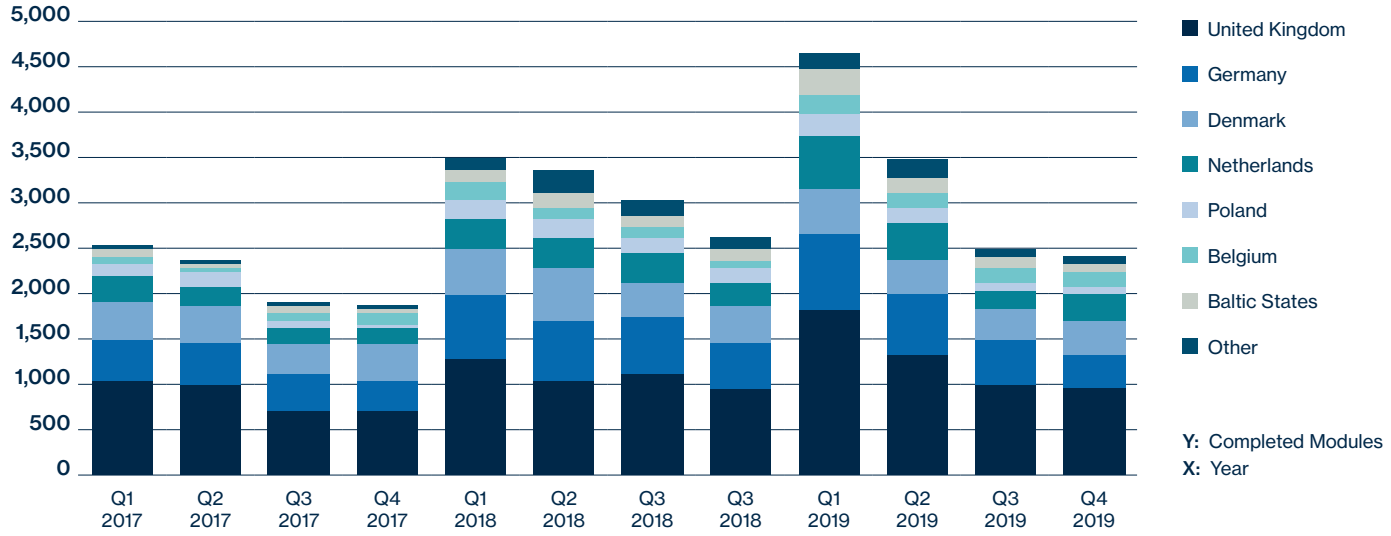
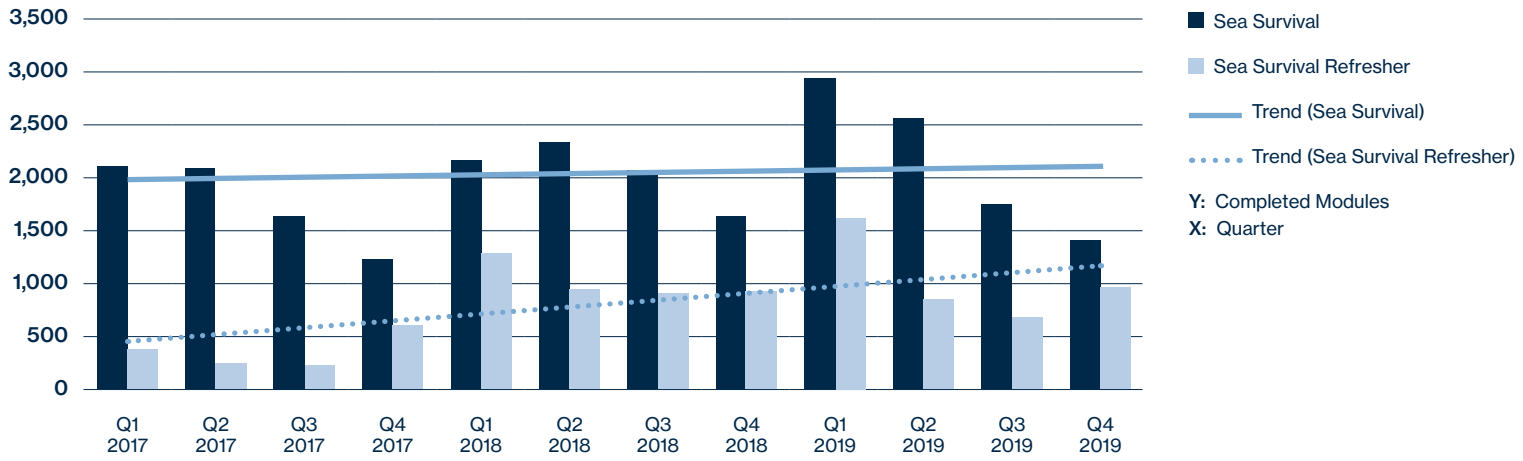


Table 5: Training modules delivered in each European market in each quarter of the reference period

Market	Q1 2017	Q2 2017	Q3 2017	Q4 2017	Q1 2018	Q2 2018	Q3 2018	Q4 2018	Q1 2019	Q2 2019	Q3 2019	Q4 2019	Total
United Kingdom	1,041	984	687	713	1,288	1,057	1,133	947	1,848	1,338	991	961	**12,988**
Germany	476	487	452	327	722	681	616	523	853	675	523	398	**6,733**
Denmark	401	421	347	440	535	576	406	400	503	405	339	357	**5,130**
Netherlands	325	229	167	152	321	342	327	292	575	395	202	311	**3,638**
Poland	96	142	65	58	203	193	158	155	258	182	95	82	**1,687**
Belgium	110	60	83	107	218	150	123	82	217	178	148	165	**1,641**
Baltic States	73	52	85	53	140	160	130	114	296	173	131	100	**1,507**
Other	38	29	35	26	130	238	185	128	160	176	90	67	**1,302**
Total	**2,560**	**2,404**	**1,921**	**1,876**	**3,557**	**3,397**	**3,078**	**2,641**	**4,710**	**3,522**	**2,519**	**2,441**	**34,626**

Figure 7: Graphical representation of the training delivered in each quarter of the reference period (both modules)



shift in training activity to, for example, the United Kingdom where growth in installations continues to be strong

- The top 4 markets have remained constant over the reference period. Belgium and the Baltic States have emerged as significant providers of training, overtaking Poland in 2019 in terms of courses completed

Table 5 lists the total number of training modules (Sea Survival and Sea Survival Refresher) completed in each quarter of the reference period. Figure 6 shows the same data graphically.

Figure 6: Key Points

- Analysing the training by quarter, we see a regular cyclical/seasonal pattern in training activity with peaks in Q1 of each calendar year, the reducing levels in each subsequent quarter. This is likely due to weather constraints reducing windows for construction activity in the winter months, with a greater proportion of the workforce therefore available to undertake non-construction activities, including training, maximising personnel availability in the summer months when construction activity intensifies. As the market grows, this seasonal effect will likely grow in direct proportion
- This pattern is likely to be self-reinforcing as those completing Sea Survival training in Q1 of a given year will require Sea Survival Refresher training in the same quarter two years later
- Looking at GWO training conducted globally, this seasonal effect will be to an increasing degree mitigated (smoothed) as markets in the southern hemisphere come online.
- The pattern is less pronounced in individual markets, but this can be likely be explained by the constant exchange of personnel between projects in different markets with specific schedules and weather restrictions
- The large numbers completing training in the United Kingdom in Q1 2019 indicates a significant expansion of the workforce here in this quarter

Figure 7: Key Points

- Plotting the Sea Survival and Sea Survival Refresher training data separately, we see a similar annual cyclical pattern, albeit with a great volume of refresher training completed in Q4 of each year

- More significantly, the three-year trends show a generally stable rate of Sea Survival completions, and therefore in numbers of people sitting the course for the first time and entering the offshore workforce. It should be noted however that this number will include some previously trained personnel whose training had lapsed

- The rate of Sea Survival Refresher completions has grown rapidly over the reference period indicating some stabilisation of the workforce through retention within the industry of trained, skilled personnel (explored further below).

Workforce Retention

Since we only have a full dataset for 2017-19, the only year we can calculate accurate figures for the overall size of the workforce is 2019. However, it is possible to analyse the data to understand, in broad terms, the stability of the workforce over time.

- Of the 7,231 persons who completed Sea Survival training in 2017, a total of 3,227 (45%) completed either Sea Survival or Sea Survival Refresher training in 2018 or 2019, suggesting just under half of the new entrants to the workforce in 2017 remained in the workforce at the end of the reference period, with the remainder presumably having left the offshore workforce either temporarily or permanently

- These figures are based in unique WINDA IDs and therefore consider those who, due to local, project or company requirements complete the training annually. It does not exclude those who completed the training for a single short-term visit to an offshore site. Nor does it consider those already in the workforce but whose training had lapsed and were therefore required to complete the Sea Survival course again in 2017

- Of the 1,474 persons who completed Sea Survival Refresher training in 2017 (and who were presumably already in the workforce for at least a year beforehand), a total of 1,032 (70%) completed either Sea Survival or Sea Survival Refresher training in 2018 or 2019

- A much greater proportion of those already in the workforce in 2017 remained in the offshore industry (or at least trained to work offshore) in 2019, indicating a sizeable core personnel repeating the training regularly, but with a potentially sizeable annual turnover. Further analysis of data in subsequent years is required to explore this aspect of the data further, identify any lasting trends and understand the reasons for relatively poor retention.

Table 6: Training delivered by the ten largest training providers during the reference period

Provider	Market(s)	2017	2018	2019	Total
RelyOn Nutec	BE DK DE NL UK	1,840	2,856	2,677	**7,373**
Maersk Training[5]	DK UK	1,767	1,596	1,286	**4,649**
Advanced Industrial Solutions	UK	905	1,097	1,248	**3,250**
Complete Training Solutions	UK	633	817	775	**2,225**
Fire and Medical Training Centre	NL	310	604	733	**1,647**
Delta Safety Training	NL	271	270	371	**912**
Deutsche WindGuard Offshore	DE	229	358	317	**904**
ISC Training & Assembly	DE	233	281	379	**893**
Humberside Offshore Training Association (HOTA)	UK	96	312	463	**871**
Heinemann Projektberatung	DE	263	239	311	**813**
Others	-	2,477	4,482	4,943	**11,088**
Total	**24,721**	**8,761**	**12,673**	**13,192**	**34,626**

[5] Figures for Maersk Training A/S and Maersk Training UK Ltd combined

Figure 8: Graphical representation of the proportion of training delivered by the largest providers (plus all others)

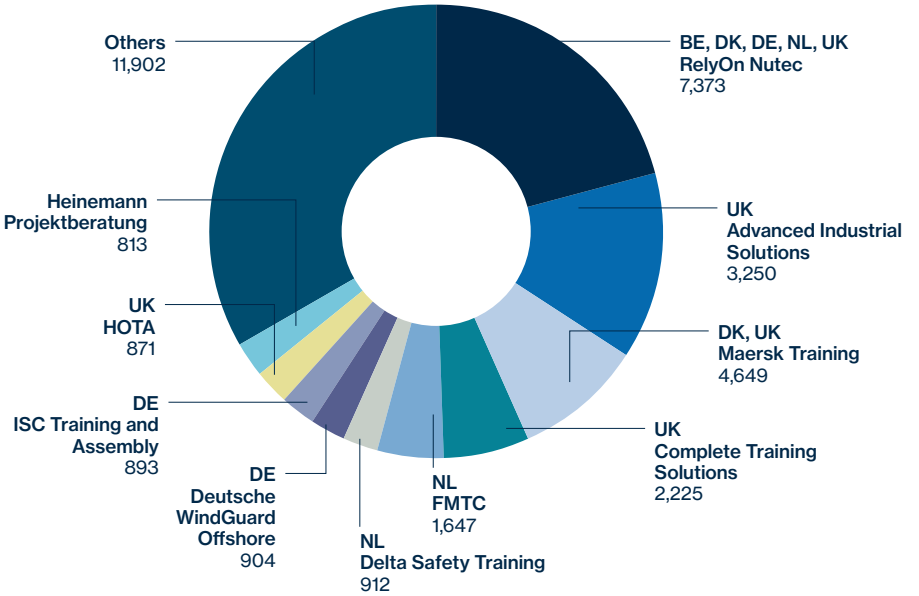


Table 7: Training providers per European market during the reference period

Market	Training Providers	Courses Completed	Mean Courses per Provider
United Kingdom	17	12,988	764
Germany	7	6,733	962
Denmark	8	5,130	641
Netherlands	8	3,638	455
Poland	7	1,687	241
Belgium	2	1,641	821
Baltic States	7	1,507	215
Other	17	1,302	77

Training Providers

Table 6 lists the number of training courses delivered in each year of reference period by the ten largest training providers (plus all others). For each provider, it lists the market(s) in which they are active. Figure 8 shows the same data graphically.

Table 7 lists the number of training providers active in each of the European markets during the reference period and the mean number of courses delivered per provider.

Table 6, Figure 8, Table 7: **Key Findings**

- The 'Top 10' providers account for 34% of all training delivered
- RelyOn Nutec dominates the market, providing over one-fifth of all training, across all five largest markets (in terms of capacity installed or under construction).
- The 'Other' category consists of a further 58 providers, each delivering less than 650 courses over the Reference Period
- In general, the number of training providers in each market correlates with the number of courses completed and the overall size of the offshore wind sector
- Poland and the Baltic States are again notable exceptions with relatively large numbers of training providers given the absence of offshore wind capacity in these countries
- Training in Germany and Belgium appears to be most concentrated with a small number of providers delivering large numbers of courses
- The United Kingdom has the largest number of providers, reflecting the size and wide geographical range of the United Kingdom's offshore wind sector
- It shows a relatively stable picture across the Reference Period but with Maersk Training notably squeezed. Other, smaller training providers have increased their market share.

Part 2:
How does the volume of training correlate with the volume of installation, commissioning and O&M activity?

As described in Chapter 2, a simple comparison of the amount of training delivered with the volume of installation, commissioning and O&M activity, does not allow for an accurate estimate of personnel per MW requirements, principally due to the two-year validity of GWO training module certificates. For example, an individual who completed training in 2018 forms part of the workforce in 2019 but would not be included in a calculation that divides completed training by installed MW. Even if no training took place in 2019, a sizeable workforce trained in 2017 and 2018 would be available to install and operate multiple GW of projects. A measure of total workforce size is therefore more appropriate for estimating future training needs in emerging markets,

With a three-year dataset, we can fully estimate the workforce size for 2019. This is calculated by examining each WINDA ID and determining the period(s) during which each individual held an in-date Sea Survival or Sea Survival Refresher certificate. These time periods were then examined on a month-by-month basis. All WINDA IDs with an in-date certificate at the end of each month were considered part of the workforce for that month. The results are shown Table 8.

We can also estimate the size of the workforce engaged in O&M activities. At the end of 2019, there were 5,047 grid-connected offshore wind turbines in Europe with a total capacity of 22,072 MW[6]. A total of 115 projects where in operation or partial operation (O&M) phase[7].

Table 8: Size of the GWO-trained European offshore wind workforce in 2019

Month	GWO-trained workforce
January	20,935
February	21,524
March	22,288
April	22,956
May	23,453
June	23,854
July	24,157
August	24,432
September	24,583
October	24,792
November	25,005
December	25,138

We suggest that the following ratios can be applied when calculating O&M phase workforce strategies:

- 1 technician per 3 turbines
- 3 balance of plant technicians per project

An estimate of the total O&M workforce therefore = (5,047 / 3) + (3 x 115) = 2,027.

Subtracting this value from the total workforce gives an estimate of the workforce engaged in construction and installation activities. This equals 23,111.

A total of 3,627 MW of new offshore wind capacity was added in 2019[8].

[6] https://windeurope.org/about-wind/statistics/offshore/european-offshore-wind-industry-key-trends-statistics-2019/
[7] RCG analysis, GRIP data
[8] https://windeurope.org/about-wind/statistics/offshore/european-offshore-wind-industry-key-trends-statistics-2019/

Table 9: Summary of potential limitations to the calculated 'persons per MW' baseline

Limitation	Effect on workforce estimate
Assumption that entire offshore workforce is trained to GWO standards. The figures assume that those working the offshore wind industry are trained to GWO standards. While GWO members cover a large proportion of the industry, part of the workforce may be missed by only analysing completed GWO courses.	▼
Absence of detail on the job role of each trained individual The figures do not distinguish between those directly involved in installation and commissioning activities (offshore technicians, supervisors etc) and those in support roles (such as safety and quality personnel, client representatives, those undertaking environmental monitoring/compliance activities and vessel crews – see also next bullet). These roles are all critical to the construction phase and must be considered in resourcing calculations, but may inflate the estimate of the 'construction' workforce.	▲
Variability in application of GWO standards to projects The requirements for personnel to be trained to GWO standards vary from project to project. In some cases, all personnel entering the wind farm site boundary (including those undertaking pre-construction survey activities) are required to complete all or some of the GWO Basis Safety Training. In other cases, only those transferring onto a foundation structure or transition piece are required to complete the training – other personnel working offshore will generally complete a nationally-recognised basic safety training course for seafarers. The workforce requirement for an individual project will depend on the developer's minimum requirements, and local safety and training regulations. The figures therefore represent an 'industry average' which encompasses a range of approaches.	?
Turbine size variability The capacity installed covers all projects under construction in Europe. Turbine sizes ranged from under 4 MW (65% of installed capacity) to over 8 MW (4%) but are, on average, growing year-on-year. Per-turbine workforce requirements (for installation) are unlikely to vary significantly with turbine size. As such, the average 'persons per MW' figures are likely to be excessive for projects utilising larger turbines. The figures therefore represent an 'industry average' recognising the range of turbine sizes deployed.	▲

Table 9: *Continued*

Workforce build-up and speculative training The workforce increased by approximately 20% across the year, yet the capacity installed each month remained relatively constant. This may indicate: • A large cohort of personnel undertaking training to work on new projects entering construction, including those speculatively undertaking or refreshing the training in anticipation of future opportunities (particularly in the UK where many offshore workers are self-employed) • Training undertaken in support for large-scale foundation installation campaigns in 2019 and 2020 which will only be captured in the 'capacity installed' figure for 2020 and beyond Each of the emerging markets have forecast installations beyond 2024 so the inclusion of a growing foundations installation workforce anticipates future workload to accommodate industry growth.	▲
Workforce retention The 'workforce' figures include all persons with a valid Sea Survival (or Sea Survival Refresher) qualification. This will therefore include those who have left the European workforce (either due to career change or emigration), those who required the training for a one-off visit or short-term assignment. The workforce size may therefore be an overestimate in this regard, but similar considerations will apply to persons training in the emerging markets.	▲
Package phasing At any one time, foundation installation, cable installation and turbine installation and commissioning will be taking place, often simultaneously on a single project. The degree of overlap and length of each campaign will result in a changing workforce requirement throughout the construction phase. The figures presented include projects at all such stages and therefore represent an industry average across all such campaigns and technical specialisms.	?
Lag time 2019 is the only calendar year for which complete workforce data is available and the only one where data can be correlated with construction activity/effort. The training data will likely include persons engaged in large-scale foundation installation works for projects that commenced construction in 2018 or 2019. However, since turbine installation has been used as measure of installation effort, there is a lag between the foundation construction effort (and the workforce required to deliver it) and it being reflected in the installation MW data. This may result in over-estimating the workforce for 2019 as the workforce is expanding to deliver year-on-year growth.	▲

We can therefore conclude that 23,111 trained persons were equated to installations of 3,627 MW of capacity throughout 2019, equating to an *annual average* of 6.4 persons per MW.

On a large project timescale of typically 2.5 years, we can extract a figure of 6.4 / 2.5 = **2.5 persons per MW per project.**

Readers should however be aware of the limitations with the 'persons per MW' figures and the inputs used to calculate them – listed in Table 9 - and their relevance and application to the emerging markets. Each limitation could be subject to further data gathering and analysis in order to reduce uncertainty in the figures.

What is the global offshore wind pipeline like for 2020-22?

Table 10 lists the offshore wind pipeline for the target markets to 2024, as forecast by GWEC as of Q1 2020.

GWEC collects installation data from regional or country wind associations, input from industry experts and reports published by public authorities. GWEC's offshore wind forecasts are based on the GWEC Market Intelligence's global offshore wind pipelines as well as input from major stakeholder active in each market.

GWEC takes into account potential impact of COVID-19 on global wind installations, but maintains its forecast for the Chinese offshore wind market considering the latest offshore wind developments in China, the recovery of local supply chain and the 2021 deadline ahead of the local industry. For other markets, it is still too early to quantify the impacts of the pandemic. As such, the Q1 2020 outlook is unchanged in this report.

Market Commentaries

North America

The US is expected to be the only offshore wind market in North America during the forecast period. As of 2019, there is only one 30 MW offshore wind project installed in US waters, however great progress has been made in the past few years in developing the sector.

On the federal level, the Bureau of Ocean Energy Management (BOEM) has completed 15 active commercial leases for offshore wind development that could support more than 21 GW of generating capacity. On the state level, the East Coast cluster of Maine, Connecticut, Massachusetts, New York, New Jersey and Maryland are driving strong demand for offshore wind energy. More than 10 states have offshore projects in different stage of development to date, of which six states have offshore wind procurement targets through either legislation, conditional targets or executive orders. The recently increased offshore wind targets in New York and New Jersey, together with the 2030 offshore wind targets released by Connecticut and Maryland in 2019, have brought the country's total offshore wind procurement targets from 9.1 GW in 2018 to 25.4 GW in 2019.

As of December 2019, the US offshore wind pipeline totalled more than 26 GW in federal lease areas issued to date. According to GWEC Market Intelligence, out of this pipeline, 15 offshore wind projects totalling 10,603 MW are expected to be commissioned by 2026.

China

As the largest offshore market outside Europe, China surpassed the United Kingdom as the world's leading offshore market in new installations in

Table 10: Forecast installations (in MW) for key markets to 2024

Market	2020	2021	2022	2023	2024	Total
North America[9]	12	0	283	1,750	3,675	**5,720**
China (mainland)	3,500	4,000	3,000	4,000	4,500	**19,000**
Taiwan	109	1,470	900	750	350	**3,579**
Japan	0	0	140	220	500	**860**
Brazil	0	0	0	0	0	**0**[10]
Vietnam	200	300	100	200	300	**1,100**
South Korea	60	100	100	100	200	**560**

[9] United States and Canada - although GWEC are not currently forecasting any offshore installations in Canada
[10] GWEC forecast the first offshore wind installations in Brazil for 2028

2018. The country's target of 5 GW grid-connected offshore wind by 2020 was already reached in 2019, following new installation of 2.5 GW of offshore wind that year. Currently, China has total offshore wind installed capacity of nearly 7 GW, the third-largest in the world.

According to regulation released by the National Development Reform Committee (NDRC) in May 2019, offshore projects approved before the end of 2018 are eligible for a FiT (Feed-in-Tariff) of CNY 0.85/kWh if the project is fully grid-connected before the end of 2021. An installation rush is therefore expected to take place in both 2020 and 2021. Although more than 40 GW offshore wind projects has been approved by national or provincial governments before 2019, GWEC Market Intelligence believes that only 7.5 GW will be connected in 2020-2021. This is primarily due to supply chain bottlenecks which have impacted availability of blades, main bearings, cables and turbine installation vessels.

After the short-term installation rush, the Chinese offshore market will continue to grow. A key driver will be the ambitious long-term offshore wind targets set by coastal provinces: Guangdong plans to build 30 GW offshore wind by 2030, followed by Jiangsu (15GW), Zhejiang (6.5 GW) and Fujian (5 GW). In addition, the local offshore wind supply chain is likely to mature in 2-3 years, with further cost reductions realized through industrialization and economies of scale.

Taiwan

By the end of 2019, Taiwan had 128 MW of offshore wind capacity installed at Formosa 1, its first commercial-scale offshore wind farm. Taiwan is well-positioned to build on this progress and become the second largest offshore wind market in the Asia-Pacific region. Strong policy ambitions are driving long-term market development, with 5.7 GW of offshore wind targeted by 2025. According to a policy unveiled in late 2019, an additional 10 GW will come online in the decade thereafter, with 1 GW added year-on-year to 2035.

Offshore wind is one of the critical sectors for Taiwan's green transition, as limited land space has compelled policy makers to look to coastal zones for power production. A selection round and auction in 2018 drew interest from local and foreign developers, encouraged by a high offshore wind FiT. Sector growth is steadily guided by the government's target of 20% renewable energy by 2025, as well as commitments to improve energy security and economic competitiveness in the region. The Ministry of Economic Affairs (MOEA) has affirmed that offshore wind will spur creation of jobs and a regional supply chain hub in Taiwan, while catering to the increasing number of industrial actors which require renewable energy for their operations.

Challenges ahead include electricity market reform and high local content requirements in future tenders, as the local/regional supply chain is still in early stages of development. While FiTs were reduced for offshore wind in 2019 and in 2020, transparency of a steady pipeline for long-term capacity growth will continue to attract international developers, foreign financing institutions and, increasingly, local financing to the offshore market.

Japan

Japan's early offshore wind development was jeopardized by a strict environmental assessment process, which dampened installations. By the end of 2019, only 65.6 MW offshore wind was brought online. However, positive steps have been made recently, which indicate that deployment of offshore wind will accelerate from 2022.

In 2017, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) amended its Port and Harbor Law to promote offshore wind power development at port-associated sea areas. Further legislative progress was made in 2019 through an act promoting marine areas for renewable energy generation, and the announcement of 11 offshore wind promotion zones. Four of these zones (Goto in Nagasaki, Choshi in Chiba, Yurihonjo in Akita, Noshiro in Akita) are nominated as promising areas where local residents have agreed to develop offshore wind projects, with Goto selected as the first zone dedicated to the promotion of offshore wind. In addition, the MLIT amended the Port and Harbor Law in October 2019 to allow developers and construction companies to use port quays for offshore wind power development.

The first offshore wind auction is expected to be held in Japan during the summer of 2020. The creation of a positive regulatory environment has not only drawn the attention of local large utilities including Tokyo Electric Power Company (TEPCO), but of local and international developers and suppliers throughout the offshore wind value chain. As of the end of 2019, more than 13 GW offshore wind projects are in the Environmental Impact Assessment (EIA) pipeline, with large-scale offshore wind projects expected to come online from 2022 onward.

South Korea

With 560 MW of offshore wind capacity to come online by 2024, South Korea is a market to watch in the Asia-Pacific region. There are strong policy drivers in place, including a 13 GW offshore wind target by 2030, which forms part of the government's program to generate at least 30% of power from renewable energy by 2040. As an industrial hub for the offshore oil and gas industry, South Korea has already established the local supply chain for offshore wind turbines, components and balance of plant. A Renewable Portfolio Standard scheme is also in place to encourage investment in renewable generation. International investors currently working on offshore wind project development

in South Korea include Macquarie, Northland Power and Equinor.

South Korea's first commercial farm, the 30 MW Tamra project off Jeju Island, was completed in 2017 and the first phase, 60 MW, of the Southwest Offshore Wind Project is expected to be connected in 2020. Most projects are concentrated in South Jeolla, North Jeolla and South Gyeong-sang, including a massive 1 GW floating wind project. Industry partnerships are supporting growth in port cities like Ulsan, and tend to bring together private players with state-owned companies and local governments, ensuring a public stake in the sector's development. Potential barriers include local fishing interests, limitations of domestic supply chain in the initial years and the lack of a fixed support scheme for developers.

Vietnam

Vietnam has the distinction of being the key market in Southeast Asia for offshore wind development, although Indonesia and the Philippines also hold promise. As of the end of 2019, Vietnam has 99 MW intertidal projects installed. With a coastline of more than 3,000 km and an average wind speeds of 8-9m/s in the south, 475 GW of fixed and floating offshore wind technical potential was identified in the World Bank Group's Going Global report.

On top of its excellent wind resources, recent development in Vietnam has been driven by the offshore wind Feed-in Tariff of USD 0.098/kWh introduced in September 2018. Ahead of the cut-off date of the FiT on 1 November 2021, wind developers and investors are rushing to commission their projects before the deadline. Around 200 MW of offshore wind turbine orders were announced in 2019, with more expected to follow in 2020.

After 2021, offshore wind growth in Vietnam may slow as the procurement mechanism transitions from FiT to auction. However, market growth will continue to be driven by the country's accelerating electricity demand, an impending power crunch and the government's renewable energy targets. Its master plan, Power Development Plan 7, aims for 6 GW of wind energy by 2030. The forthcoming Power Development Plan 8 may further increase this target, with specification for offshore wind.

Brazil

Brazil has tremendous technical potential for fixed and floating offshore wind, estimated at 1.2 TW in the World Bank Group's Going Global report, released in October 2019[11]. While commercial installations are not expected before 2025, the political ambition and regulatory environment are coming into place. In 2018, the Senate approved Bill 484 which authorises offshore wind auctions for projects in inland waters, territorial waters and Brazil's EEZ. Brazil's energy planning authority, the Energy Research Office (EPE), is also working on a roadmap for offshore wind to 2035.

For now, developers and investors are observing the progress of offshore pilot projects in Ceará and Rio Grande do Norte. State-owned oil company Petrobras will be an important actor in determining the trajectory of the offshore sector, and has already undertaken partnerships to cooperate on policy, legislation and research for offshore wind.

Expected workforce training requirements

Applying the baseline annual average workforce requirement figure to the forecast pipelines (as listed in Table 11), we can estimate the size of the workforce that will be required to install the forecast capacities. These estimates should be read with reference to the interview findings and further commentary in Chapter 4.

In line with an aggressive offshore wind deployment strategy, particularly in China and North America, a large, skilled offshore wind workforce of almost 77,000 people will be required to deliver the projected installations to 2024.

This represents a significant opportunity for the industry's largest manufacturers and owner operators who use GWO to establish standardised training in the target markets, and for established and new-entrant training providers to grow their businesses by expanding to accommodate the potential demand.

Key to harnessing these opportunities will be the degree to which GWO training can be accepted (including by regulators and the local supply chain) and embedded in the target markets.

[11] http://documents.worldbank.org/curated/en/716891572457609829/pdf/Going-Global-Expanding-Offshore-Wind-To-Emerging-Markets.pdf

Chapter 4: Interview Findings and Commentary

This chapter summarises the findings of a series of interviews conducted with GWO and GWEC member organisations and GWO certified training providers. These interviews supplement the quantitative analysis presented in Chapter 3 and sought to gather the views of key stakeholder groups to understand their strategies for ensuring projects are adequately resourced and opportunities to establish GWO training standards in the target markets.

GWO and GWEC Member Organisations

How do turbine manufacturers and owners/operators determine the scope of technicians needed for each project?

The responses suggest that:

- Owners/operators tend to contract turbine manufacturers to provide personnel for installation and subsequent servicing and maintenance. At construction stage therefore, these owners/operators will have a relatively low requirement for GWO-trained direct employees. However, the owner/operator may still require all persons engaged on the project to be GWO trained at all stages of the project and include this as a requirement within the contract with manufacturer for installation and subsequent service contract

- The resourcing model of one respondent was to sub-contract most offshore activities to specialist contractors, while directly employing onshore control room, marine co-ordination and office-based roles. These roles may or may not require GWO training depending on the approach taken

- Manufacturer and developer respondents use fixed frameworks which define manning requirements for each project based on project size, timeline and factors including location, contracted work scope and skills/specialisms required. These frameworks are based on accumulated knowledge of workforce requirements and risk assessment, refined over several years often using Lean-type principles

- Manning standards – and therefore training requirements – are driven by the minimum number of people required to safely complete a task but influenced by local legal requirements, customer requirements, and technical competence/experience of the team. Some jurisdictions have alternative requirements for first aid and work at height training, and multiple national standards for medicals (certifying fitness to work offshore) must be complied with for workforces that work cross-border

- Sub-contracting is an important element of the industry and respondents generally stated that manning of projects depends on specialist contractors for certain activities (for example, pre-assembly, inspections, bolt torqueing).

How many people are required to support the different stages from installation and commissioning through to ongoing service? How does this change over time? What are the influencing factors?

- Owners/operators have a small core of personnel that continue from stage to stage of a project, with the bulk of work at each stage contracted to, for example, manufacturers, EPCI contractors, cable contractors and a range of more specialist trades, each responsible for ensuring a workforce trained to minimum project standards. Fluctuations over time will vary depending on the joint-venture agreement for the division of tasks and the contracting arrangements – use of contractors will minimise the in-house workforce requirements, but does not reduce the overall number of trained personnel required

- One OEM was able to provide exact figures for the turbine installation and commissioning phases. A typical project requires 12 technicians per installation vessel per shift (shifts are 12 hours) for installation, and a team of 20-25 technicians working day shifts for commissioning. This allows the OEM to install and commission a turbine every 24 hours. For large projects using multiple installation vessels, the manning requirement grows accordingly. This OEM did not foresee a change in manning requirements as turbines increase in size

- A respondent from a turbine service provider indicated that per turbine workforce requirements are affected by the type of turbine, type of work required, volume of scheduled maintenance, number of reported faults, weather, travel time to site, holiday and sickness cover. A team of at least 2, up to a maximum of 5 is required for most turbine service work. Multiple teams may be working on a single project site at any one time.

What factors influence how training requirements are assessed? How do local regulations and the availability of training affect decision-making?

- Owners/operators take a risk-based approach to assessing training requirements. New GWO courses are assessed against existing courses and implemented if appropriate. The example of the GWO Enhanced First Aid training standard was cited as an important addition to the range of available courses due to the remoteness of wind sites – with risks likely to

increase as projects are built further from shore (and assistance in an emergency)

- All local regulations are adhered to and this may require specific local, or adapted, training for some markets. Local providers are used where possible to reduce travel costs. In-house training remains important (including where no GWO course/module is available for specific risks or skills)

- One respondent stated that local requirements for electrical qualifications vary from country to country and therefore training programmes must be adapted to ensure the workforce has the necessary training to safely and legally operate.

What could resource assessment look like for pipeline projects in North America, Taiwan, China and other emerging markets?

- No respondents were able to provide definitive numbers for the resource requirements in the emerging markets. However, where manning frameworks are in place, these would be applied as they are in Europe (subject to any local legal requirements)

- One respondent stated that, in the short term, they would continue to use Europe-based technicians to install, commission and service projects in the emerging markets - the local workforces generally lack the necessary competence and experience. There is however a desire to appoint local technicians and one organisation has a tie-up with a local training provider in one of the key markets to support the development of local technical teams

- Other factors that were raised included the levels of unionisation in some markets (notably the USA) and requirements to use local workers unless it can be demonstrated that the required roles are sufficiently highly skilled to allow foreign workers into the market (as in Japan)

- Difficulties with electrical competence were raised due to the marked variation in training and qualification requirements across markets. It is seen as the 'missing element' and raises questions as to whether European companies will be able to recruit the workforces required to operate safely and effectively in emerging markets. It should be noted that this remains an issue, albeit to a lesser extent, in Europe

- One respondent suggested GWO setting up training centres using employed instructors to support the embedding of the GWO standards and maintain quality

- In North America in particular, there is an opportunity to support technicians 'transferring in' from oil and gas, and the approach to training – including the GWO course – should aim to support this.

Training Providers

What factors influence resourcing decisions?

Training providers told us that the following factors affect resourcing decisions:

- Market demand – resourcing is therefore generally focused in areas with large numbers of wind farms or near clusters of supply chain companies. Training providers often undertake forecasting (based on volume of training previously delivered at a training centre, and expected demand from locally based projects and technicians) to ensure centres are adequately resourced with competent trainers, equipment etc.

- Availability of trainers – some providers operate 'train the trainer' programmes to ensure adequate numbers, and to assure quality of delivered courses

- Availability of visas for trainers to work outside their home market.

What can the wind turbine industry do to ensure adequate training is made available?

- Stricter and more frequent audits to assure quality

- Provide clarity and control over the training equipment and training centre infrastructure required to gain accreditation to GWO standards

- Take a pragmatic approach - listen to people in the emerging markets and assist them into the industry (rather than imposing the European model) and being sensitive to local nuances

- Ensure instructors are formally qualified, with some oversight from GWO, and that they have access to sites (including WTGs) so they have sufficient experience of the real working environment to deliver effective, targeted training

- Benchmarking of non-GWO courses. One developer told us that they operate a 1-day course that allows limited access offshore to allow accompanied work where the person has relevant training (possibly from another industry) but which is not GWO

- Resist the temptation to make GWO easier. Instead, make it more accessible. We need to learn from the experience of the oil and gas industry and new markets need to understand that if they do not follow the standard, opportunities to upscale (and upskill) their local workforce may pass them by.

Market-Specific Considerations

This subchapter provides a more anecdotal, and unsubstantiated, summary of other matters that could skew the analysis at a local level and to a greater or lesser degree. It considers where the calculated 'persons per MW' baseline may need to be adjusted for specific markets. Each point raised is worthy of deeper consideration and consultation at individual market level.

North America

GWO training is growing in the North American market onshore (3000+ people in the GWO trained workforce and +83% growth in training during 2019). In addition,at least two training providers delivering the core BST modules, plus Sea Survival for offshore technicians will be certified by the end of 2020.

However, the standards have yet to penetrate the market to the same degree as they have done so in Europe. GWO has acknowledged this challenge and is represented by the GWO North American Committee to ensure a constructive dialogue is maintained with all key stakeholders.

The Committee comprises representatives from 11 major owner operators and turbine manufacturers active in North America and their objective is to ensure GWO standards are made available as a complement to existing local resources such as other local maritime and construction training bodies. Many of the committee members represent diversified energy companies and acknowledge that workers migrating from onshore to offshore may not have GWO training and may resist retraining, potentially with a perception there is an overlap with existing skills, for work offshore.

In contrast, job creation in North America is of key importance politically, and the political imperative may translate into more labour-intensive approaches being adopted as the market matures. This could raise the number of operatives per MW installed and represent a significant opportunity for increased standardisation if these barriers to entry can be overcome.

Taiwan

GWO training is being embraced in the Taiwanese offshore wind market, and we anticipate volumes will follow the general analysis.

Consideration should be made of local climatic conditions and related labour regulation. Taiwan has specific requirements that apply to workers when exposed to elevated temperature, working at height and working with small components – conditions that can increase stress and therefore risk. Regulations implement mandatory rest periods during daily activity. Some rest time will be offset by climate control in the working environment (during vessel transits, office-based work etc), but the net impact would be an increase in worker numbers per MW installed.

China

Adoption of GWO standard training has increased rapidly since 2018. Last year GWO member company Goldwind opened a substantial training centre at which Sea Survival will be a core element and over 3000 BST training modules were completed in the calendar year.

Consideration should be made however of the fact that China has its own, and massive, wind turbine production capability and that internalisation of all associated service industries is both desirable to the Chinese authorities and will be more closely controlled.

While it is not inconceivable that China could or would develop its own training standards and training entities for offshore wind, GWO has strong connections with the Chinese industry. The GWO China Committee was formed in 2017, two major manufacturers and one owner operator are GWO members and the organisation has a Secretariat function in Beijing run in co-operation with the China Wind Energy Association (CWEA) under the leadership of the Association's CEO Mr Qin Haiyan. GWO has already translated its entire portfolio of training standards into Chinese and is expecting a continuing increase in adoption in the coming years.

Japan, Brazil, Vietnam, South Korea

Brazil is one of the world's fastest growing regions for GWO training and should this market eventually open its waters to offshore wind, there is a compelling case for training providers to develop standardised courses. Japan and South Korea have a more modest number of training providers, but their forecasts are robust. GWO is making considerable efforts to open these markets via its partnership with GWEC and in the creation of local GWO Pioneer initiatives. Vietnam again represents a considerable opportunity for GWO member companies to make standardised training available in the region. South East Asia already counts GWO centres in Thailand, the Philippines and Malaysia, however further analysis at local level would be of benefit in establishing a more accurate picture of potential regulatory requirements and appetite for the importation of already-developed standards.

Chapter 5: Roadmap and Next Steps

The Global Wind Energy Council supports collaboration between policy makers in different countries to help them share best practices and experiences in adding clean power to their energy mix. It is the intention of GWEC's collaboration with GWO to present safety standards as one such best practice which can be adopted and promoted to help create a safer and more productive workforce in wind.

The conclusions of this report indicate a substantial opportunity for standardised safety training as the world's offshore wind sites begin their construction and installation phases up to 2024.

To help us all make the most of this opportunity, the following steps are being taken:

- Continue to develop our understanding of the market specific considerations (see Chapter 4) that may cause the workforce requirements to differ from the calculated baseline.
- Emphasise development of skilled workforces, including necessary health and safety training, in GWEC's policy recommendations and industry events in key offshore markets around the world.
- Consult with developers, regulators and wind energy associations in the emerging markets to understand the appetite for adoption of GWO standards and any local barriers that might exist.
- Continued expansion of the GWO Global Alignment Project: This project began in 2019 and will see newly aligned versions of GWO standards published in October 2020. Working groups in North America, Australia and China have reviewed every document to ensure they are fit for purpose also in those markets. Other markets will join the project over the next three years, supported by GWO's Safety Without Borders strategy.
- Investigate ways to merit GWO courses with any outstanding areas covered as a "bolt on" bringing the student up to the required GWO level.
- Develop and issue starter packs stating the required equipment both PPE and structural/facilities for developing a GWO certified training centre.
- Increase collaboration activities with associated industries. GWO is a member of the Industry Collaboration Committee alongside the G+ Offshore Wind, Renewable United Kingdom and the International Marine Contractors Association. Together the Committee's remit is to harmonise standards and remove duplication where it exists to the benefit of all operators across the wind energy supply chain. Similar opportunities for collaboration will be actively pursued.
- Implement an Instructor Qualification Standard: In 2021, GWO will introduce an IQT course to support developing markets, improving quality and accessibility of the standards.
- Implement a global quality assurance programme: This ongoing process saw the publication of new GWO Requirements for Certification Bodies and Training Providers in April 2020 introducing additional quality control measures. Updates to the requirements in April 2019 have already proven a success for governance and quality.

GWO has provided training to 86 auditors in eight global markets, and only certification bodies who have documented conformance, may now certify a GWO site. The result is a new authorised list of certification bodies published on the GWO web site. By the end of 2019 this list contained 44 certification bodies on four continents.

Table 11: Forecast installations (in MW) for key markets to 2024 and associated workforce requirements

Market	Forecast installations (MW)	Calculated workforce requirement
North America	5,720	14,300
China (mainland)	19,000	47,500
Taiwan	3,579	8,948
Japan	860	2,150
Vietnam	1,100	2,750
South Korea	560	1,400
Total	**30,819**	**77,048**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