Global Wind Workforce Outlook

2022 - 2026

GLOBAL WIND ORGANISATION

GWEC
GLOBAL WIND ENERGY COUNCIL

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Definitions

Terms	Definition
ABEEólica	Associação Brasileira de Energia Eólica - Brazilian Wind Energy Association
AP	Accommodation platform
AR	Advanced Rescue Standard
BST	Basic Safety Training Standard. A GWO training standard consisting of five training modules (First Aid, Fire Awareness, Manual Handling, Sea Survival and Working at Heights) and regarded as the minimum necessary standard to enter or work in a wind farm
BOEM	US Bureau of Ocean Energy Management
CAGR	Compound annual growth rate
CAPEX	Capital expenditure
CoHE	Control of Hazardous Energies Standard
C&I	Construction and Installation – phase of the offshore wind project lifecycle
COD	Commercial operation date
COP26	UNFCCC Climate Change Conference 26 in Glasgow
CTV	Crew transfer vessel. A boat typically designed to carry 12 technicians and three crew members from shore to the wind farm's site. Well-suited for wind farms that are relatively small and/or close to shore.
EVN	Vietnam Electricity Group
EFA	Enhanced First Aid Standard
EPE	Brazil's Energy Research Office
FA	First Aid Module, part of the BST Standard
FAW	Fire Awareness Module, part of the BST Standard
FiT	Feed-in-Tariff
GDP	Gross domestic product
GW	Gigawatts
GWEC	Global Wind Energy Council
GWO	Global Wind Organization
GWO trained workforce	People with at least one a valid GWO training certificate in the BST Standard
IBAMA	Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis - Brazilian Institute of the Environment and Renewable Natural Resources
IPP	Independent power producer
IRP	South Africa's Integrated Resource Plan
ISTS	Interstate power transmission system in India
KEPCO	Korea Electric Power Corp
LNG	Liquified natural gas

MH	Manual Handling Module, part of the BST Standard
MNRE	India's Ministry of New and Renewable Energy
MW	Megawatts
OEM	Original Equipment Manufacturer (of wind turbines)
OSS	Offshore substation
O&M	Operations and Maintenance – phase of the offshore wind project lifecycle following commissioning
PDP8	Power Development Plan VIII of Vietnam
PPA	Power purchase agreement
PTC	Production tax credit
RCG	Renewables Consulting Group Ltd
REI4P	Renewable Energy Independent Power Producer Procurement Programme in South Africa
REC	Renewable Energy Certificate
Refresher	A review or updated training that maintains the validity of a GWO training certificate after its expiry
RMIPP	Risk Mitigation Independent Power Producer Programme
SOV	Service operation vessel – a vessel designed to accommodate technicians and well-suited to service wind farms that are relatively large and/or far away from shore, thus requiring an offshore-based O&M strategy
SS	Sea Survival Module, part of the BST Standard
WAH	Working at Heights Module, part of the BST Standard

Table of Contents

Foreword

Ben Backwell, CEO, Global Wind Energy Council

Jakob Lau Holst, CEO, Global Wind Organisation

The last few years have exposed new dimensions and vulnerabilities of the global energy system. Climate change is manifesting with more severity than ever, and the current global energy crisis has made it abundantly clear the world must transition to a secure and resilient renewables-based energy system.

Wind energy is at the heart of the energy transition. It provides affordable, zero-carbon electricity to power economies, revitalise local communities and drive sustainable development. Large-scale wind projects reduce reliance on imported and volatile fossil fuels, and create a diverse value chain of job opportunities, from paper to power over the course of a wind asset lifetime.

The GWO/GWEC Global Wind Workforce Outlook 2022-2026 is the third edition of a collaborative work to focus on the people in wind energy on whom we rely for construction, installation, operation and maintenance of wind assets: wind technicians. It focuses on the enormous and transformative job creation opportunities brought by wind power to countries around the world. It also reminds us that for the industry to grow sustainably, a rapidly expanding workforce must be given the opportunity to work safely, with training according to industry best practice, so they can do their jobs with competence and live healthy lives.

That combined narrative of job creation and the need for a safe and productive workforce is achieved through a unique combination of inputs. GWEC Market Intelligence's global onshore and offshore wind outlook, aligned with GWO's Workforce Forecasting Model, paints a compelling picture in this year's report: More than half a million trained wind technicians will be needed alone to construct, install, operate and maintain the world's rapidly growing wind fleet by 2026.

The report further reveals that 86% of the workforce of wind technicians needed in the functional areas of construction, installation, operation and maintenance by 2026 will be deployed in nine countries: China, the US, Germany, India, Brazil, Japan, South Africa, Vietnam and South Korea. This group spans the Global North and South, existing and new markets for wind – truly demonstrating that large-scale wind projects bring universal job creation benefits.

Over the next five years, the industry has a clear need for increased availability of recognizable safety training in these nine key countries and many more like them. Aligning to a global industry-controlled standard for training will help increase not only competence and safety of the workforce, but bring increased workforce mobility and a greater likelihood that we can scale-up wind power installations to the levels needed to meet world-wide Net Zero targets within the required time frame.

It is GWEC and GWO's hope that this report will help to build confidence for investors and policymakers in the growing wind energy industry by forecasting steady and sustainable industry growth and increasing awareness of the tremendous opportunity to foster business and job creation. We also hope that these findings put workforce competence, availability and safety to the forefront of an energy transition agenda. As such, the information set out here will allow for data-driven decisions which enable businesses and countries to deliver on their ambitions for the energy transition.

Chapter 1: Executive Summary

This report is based upon the outputs of GWO's workforce forecasting model built with the assistance of Renewables Consulting Group (RCG). The model uses GWEC's global wind market forecasts as its primary input to determine the volume of technicians required to construct, install, operate and maintain the forecast new global onshore and offshore wind fleet out to 2026. The report seeks to answer three fundamental questions:

1. How many technicians will require wind industry standard training for the construction and installation and operation and maintenance of wind assets?

2. What is the gap between the level of penetration for GWO industry-standard training that is currently available and the level that would be required to train the forecast workforce?

3. Where are the biggest opportunities for educators and training providers to enhance wind workforce safety via GWO training?

The workforce analysis, combined with a global wind market outlook, has found that a total of 568,800 trained wind technicians will be needed to construct, install, operate and maintain the global onshore and offshore wind fleet due to be commissioned by 2026. 449,800 technicians do not hold a valid GWO training certificate. 86% of them will need to be locally sourced in the nine countries of interest for work in C&I and O&M.

GWO and RCG have improved the workforce forecasting model and refined its data inputs to factor in different workforce dynamics at play across the construction and installation (C&I), and operations and maintenance (O&M) phases of onshore and offshore wind projects (see Methodology section at the end of this report). The model does not include the workforce from other segments of the wind project lifecycle, such as research and development, procurement, manufacturing (traditionally the most labour-intensive segment in certain markets), transport and logistics, pre-installation, decommissioning and repowering, etc.

This resulting report provides an overview of the training standards available for the wind industry, workforce dynamics for the C&I and O&M of onshore and offshore wind farms, and estimates the global workforce that will need wind industry training up to 2026. The report contains five-year outlooks for the global wind market, including detailed country chapters with workforce outlooks on nine major markets of interest: the United States, China, Japan, South Korea, Vietnam, India, Brazil, Germany and South Africa.

Annual wind capacity additions around the world are projected to grow 38% from 94GW in 2021 to 128.8GW in 2026, according to GWEC Market Intelligence. By the end of 2026, the cumulative worldwide operational wind fleet is poised to reach 1,394GW, more than double the level attained prior to the COVID-19 pandemic.

As wind power expands, a well-trained wind technician workforce is needed to install new turbines and maintain the operational fleet. This gives opportunities for job creation for local and national governments that foster renewable energy as a driver for socioeconomic development, and for training providers looking to expand their activities towards developed and emerging economies. This workforce need also positions the wind industry as a key actor in supporting a just and equitable energy transition away from fossil fuels, ensuring workers and communities have a place in a modern and sustainable economy.

Key findings:

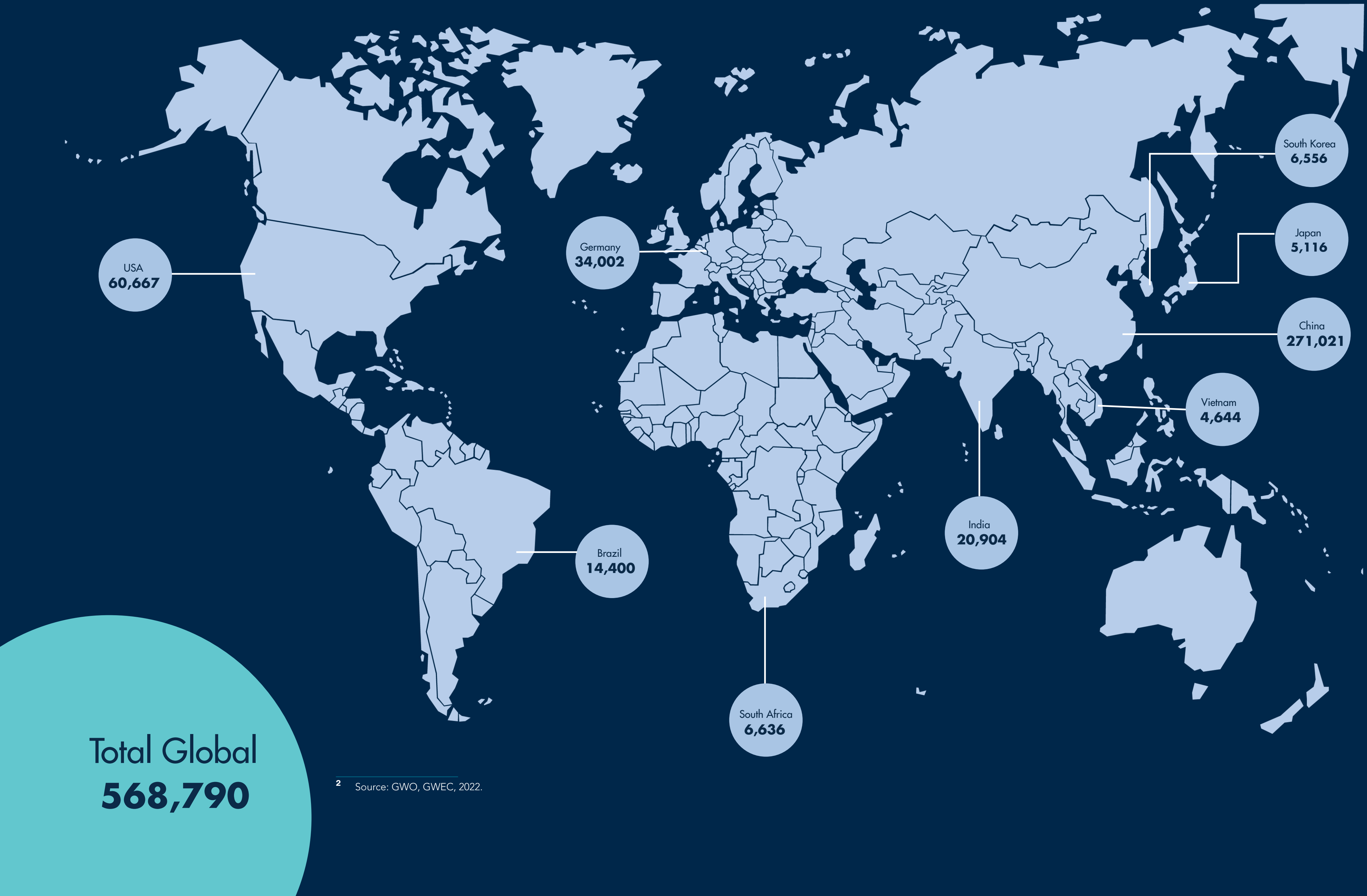
- Global onshore and offshore wind capacity is set to grow by 67% from 837GW in 2021 to 1,394GW in 2026, and a skilled workforce is needed to safely and efficiently install and maintain this fleet.
- The number of technicians that will require wind industry training to construct and maintain the global wind fleet will increase 33% from 426,700 in 2021 to 568,800 in 2026. The number of new technicians is expected to increase by 28,400 per year from 2022 to 2026, resulting in a 36% compound annual growth rate (CAGR) for trained wind technicians in the C&I and O&M segments from 2021 to 2026.
- 119,000 technicians (corresponding to 28% of the C&I and O&M workforce) already hold at least one valid certificate from GWO's Basic Safety Training (BST) Standard, as of the end of 2021. This means that wind industry training is needed for an additional workforce of 449,800 technicians from 2022 to 2026.
- 86% of these 449,800 technicians needed by 2026 will be required in nine countries: China, USA, Germany, India, Brazil, Japan, South Africa, Vietnam, and South Korea.
- The number of C&I and O&M technicians is expected to grow more rapidly in offshore wind (92% higher in 2026 compared to 2021) rather than onshore wind (27% higher in 2026 compared to 2021). However, in 2026, 87% of the C&I and O&M technicians will still be working onshore, mostly within the O&M segment.

Figure 1 - Forecast Capacity Installations and Number of People Requiring C&I and O&M Training from 2022-2026[1]

Country	Onshore		Offshore		Total
	Installations (MW)	Training Needs (# of technicians)	Installations (MW)	Training Needs (# of technicians)	People
China	249,000	241,750	39,000	29,271	271,021
USA	42,000	55,902	11,537	4,765	60,667
Germany	19,700	28,628	4,084	5,374	34,002
India	19,400	20,182	0	722	20,904
Brazil	15,600	14,154	11	246	14,400
South Africa	5,380	6,636	0	0	6,636
Japan	3,500	3,998	985	1,118	5,116
Vietnam	2,550	3,356	2,240	1,288	4,644
South Korea	1,000	1,001	1,200	5,555	6,556
Total Nine Countries	**358,130**	**375,607**	**59,057**	**48,339**	**423,946**
Global	**466,269**	**494,408**	**90,513**	**74,382**	**568,790**

1 Source: GWO, GWEC, 2022.

Figure 2- Forecast Number of People Requiring C&I and O&M Training to Meet Wind Energy Growth as of the End of 2026[2]



2 Source: GWO, GWEC, 2022.

Chapter 2:
Safety Training Standards and Growing Demand for Training

As wind industry growth accelerates and its workforce becomes increasingly mobile, being able to transfer safety training certifications across companies and countries becomes a key enabler of industry scalability and international growth.

Safety training is one of the most important elements of wind technicians' jobs, affecting both the quality of their work and the industry's reputation. Installing and servicing a turbine involves significant hazards and risks, and technicians must be trained to act safely for both themselves and for others.

The benefits of standardisation

The global wind industry collaborates to set global safety standards through GWO, creating new standards for the most common industry-specific risks, and in the process replacing commercial non-standardised training products and removing complexity. Third party certification assures quality, and enables participants, their employers and governments to verify when wind technicians are appropriately trained. This enhances an industry-wide safety culture, enables mobility and consistency of competences across teams, and reduces costs, time and travel while avoiding duplication.

How are training standards developed?

GWO training standards are the product of collaboration between HSE and training experts representing the world's largest wind industry employers. They pool knowledge and data on risks and hazards in the wind turbine environment, prioritising the creation of training standards that will have a meaningful impact on the safety of the widest possible cohort of wind turbine technicians. Inclusive design processes ensure training standards are fit for purpose.

The GWO training standards portfolio

In 2022, the GWO safety standards portfolio consists of 13 standards divided into 38 modules. Some of the standards introduce enduring skills that technicians practice every day at work, while other skills that are not used on a daily basis (such as practising first aid or rescuing an injured person from the nacelle to the ground) must be refreshed regularly.

As the most recent development, global duty-holders have aligned descriptions for entry-level job profiles for wind technicians, and agreed on skills, knowledge and abilities that can be acquired through a training pathway towards employment. This combination of GWO courses for entry-level job profiles includes GWO Basic Technical Training and GWO Basic Safety Training plus a variety of additional courses specific to the task, site and employer.

The global community of training providers

Currently, the standards are recognized and used in more than 50 countries, and can be accessed at more than 500 training centres certified to deliver GWO courses. The course certificates (training records) are owned by the individual wind technician, and can be verified in an online global training records database, establishing a mechanism for transparency and accountability for safety across the supply chain and all teams working on a given site.

Growing demand for wind safety training

The GWO training modules that were carried out most during 2021 were Working at Heights (WAH), Manual Handling (MH), Fire Awareness (FAW) and First Aid (FA), all of which are part of the Basic Safety Training (BST) Standard and must be refreshed at intervals. The number of wind technicians worldwide with an active GWO certificate in at least one of the GWO modules almost doubled from around 79,000 in the first half of 2019 to around 139,000 in the first half of 2022, signalling strong demand for GWO safety training. With a GWO trainable workforce forecast to increase 33% from 2021 to 2026, growing demand for GWO training and members' strong commitment to use GWO standards across the wind industry, training providers and educators are encouraged to become certified and help expand their adoption.

Chapter 3:
Wind Workforce Forecasts and Dynamics

Market growth and localisation policies require trained workforces in every region of the world.

As global installed wind capacity is set to grow by 67% from 837GW in 2021 to 1,394GW in 2026[3], a skilled workforce is needed to install and maintain the global wind fleet. Training providers and educators have a significant opportunity to ramp up delivery of skilled personnel training.

In the offshore wind sector, local content will be an increasingly significant success factor in the competition for new sites, with beneficial effects on the upskilling of locally trained workforces. A report published in May[4] estimated that "almost 80% of the capacity connected between 2021 and 2031 will be influenced by local content policies, more than double the share of capacity influenced by them to date". The volume of expected activity and a systemic trend towards localisation call for the expansion of GWO's network and the establishment of training centres in target markets to support local supply chains and develop local workforces.

Defining the workforce forecast

During the past two years, GWO has worked with RCG to develop a model that forecasts the growth in the number of wind technicians over a five-year horizon. The model's latest update is configured to use GWEC's global wind market forecasts as its primary input and focus on the total number of wind technicians involved in the C&I and O&M of the onshore and offshore wind capacity installed globally each year from 2021 to 2026. The results reflect the number of wind technicians that will work in the phases of C&I and O&M each year from 2022 to 2026. The annual numbers can also be viewed as representing the total number of persons, who will need to receive training to acquire or refresh their safety and technical skills during the outlook period.

The forecasts include pre-assembly work for offshore C&I. However, they exclude the workforce from other segments of the wind project lifecycle, such as research and development, procurement, manufacturing (traditionally the most labour-intensive segment in certain markets), transport, decommissioning and repowering. The wider workforce throughout the wind value chain is therefore larger than the workforce eligible for GWO training identified in this report.

The impact of refresher courses is not considered in the workforce forecasts but represents an additional opportunity for training providers and educators.

Different project phases, different workforce patterns

Growth dynamics in workforce demand can be radically different across C&I and O&M. Since demand for maintenance has a linear relationship with the size of the installed fleet, O&M employment has a steady growth profile and proves resilient to year-over-year fluctuations in installed volumes. By contrast, demand for C&I activity is volatile by nature, as relevant employment patterns vary alongside annual installations.

While investment in new capacity requires intense C&I activity and has a substantial impact on employment during the early years of industry development, demand for O&M work starts to grow slowly but gains traction as the installed base becomes more significant.

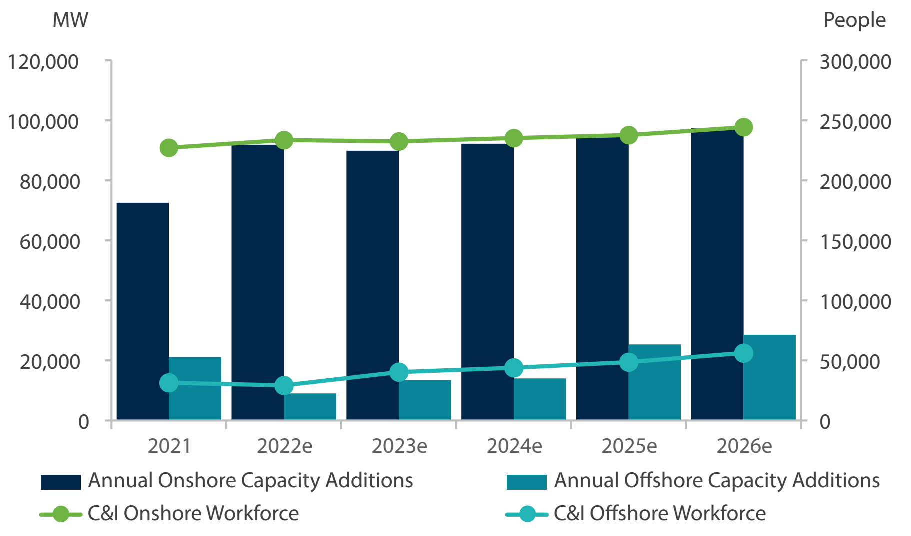
Importantly, both C&I and O&M require a significant base of locally employed wind technicians, which requires planning for local recruitment and supply of training. The volume of wind technicians deployed locally also helps to deliver socioeconomic benefits to the communities hosting wind projects and related infrastructure and facilities, and may provide a response to the potential displacement of workers from sunset industries associated with the fossil fuels sector.

Based on IRENA data, GWEC[5] estimates that 129 people are required for the construction and installation segments of a typical 50MW onshore wind farm, while this number rises to 913 people for a typical 500MW offshore wind farm. Given that the number of technicians required for the C&I of larger turbines does not deviate significantly from the headcount needed for the installation of turbines with lower power rating, annual gains in turbine rating result in a lower number of turbines and thus in a lower workforce requirement on a per-MW basis throughout the outlook period (see Methodology section at the end of this report).

3 Global Wind Energy Council, Q1 2022 Market Outlook.
4 Wood Mackenzie, Sea Change: Navigating the trillion-dollar offshore wind opportunity, Link.
5 GWEC, Wind can power 3.3 million new jobs over the next five years, pp. 6-7. Link.

These efficiency gains will occur across sectors but will have a more material impact offshore than onshore due to the scale of the rating increase. GWO expects the number of C&I technicians to increase, driven mostly by the addition of new turbines, growing from 258,500 people (227,200 onshore, 31,300 offshore) in 2021 to 300,600 (244,300 onshore, 56,300 offshore) in 2026.

Figure 3 - Global Wind Capacity Additions and C&I Technician Workforce [6]



As far as O&M is concerned, GWO expects the reduction in the number of turbines to drive more operational efficiency gains onshore. Logistics play a key role in defining offshore O&M strategies. In principle, a lower number of turbines in a wind farm should increase technicians' productivity and result in a sharp drop of people per MW. However, as offshore turbine rating increases, so does the impact of turbine failure, and operators seek to mitigate this risk by securing a permanent presence of technicians on site. Thus, as turbine rating increases, and projects become larger and are located further offshore, operators increasingly opt for offshore-based O&M strategies, which typically require a higher number of technicians per turbine.

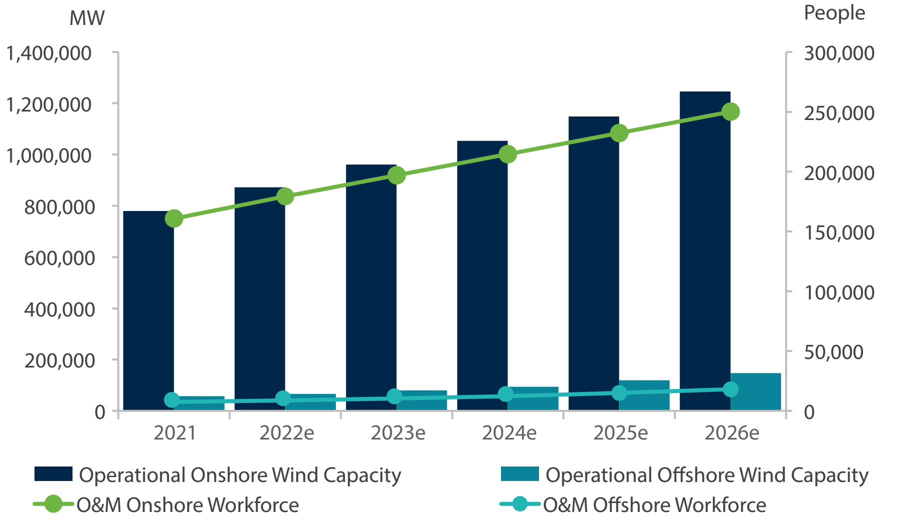
A relatively small wind farm located up to 30km from shore would allow for onshore-based O&M strategies making use of crew transfer vessels (CTVs). Larger plants, even more so if located further away from shore (i.e., >40 km), require permanent on-site availability of a substantial number of technicians, and thus are better serviced via service operation vessels (SOVs) or accommodation platforms (APs). The total capacity of the platforms or the vessels used to maintain a single wind farm works as a reliable indicator of the workforce that needs to be readily available for O&M activity (see Methodology section at the end of this report).

[6] Source: GWO, GWEC, September 2022.

Data extracted across around 50 offshore wind projects show that the O&M technician workforce tends to be lower on a per-turbine basis for wind farms that adopt an onshore-based strategy than for wind farms that employ SOVs or APs. Estimates range from 0.3 to 0.6 people/turbine for smaller wind farms located less than 30km away from shore to 0.7 to 1.5 people/turbine for wind farms that are larger in size or located >40km away.

GWO expects the total number of O&M technicians to grow 59% from 168,200 people in 2021 to 268,200 in 2026, driven by a larger operational fleet. Efficiency gains - driven primarily by technology factors such as higher average turbine ratings - will be visible onshore, reducing the number of technicians needed on a per-MW basis. The number of onshore O&M technicians is expected to grow 56% from 160,700 people in 2021 to 250,100 people in 2026. Offshore, a lower number of machines will prompt asset owners to secure a substantial presence of personnel on site, partly offsetting the efficiency gains achieved through higher rating. GWO expects the number of offshore O&M technicians to grow 143% from 7,400 in 2021 to 18,100 in 2026.

Figure 4 - Global Operational Wind Capacity and O&M Technician Workforce [7]



[7] Source: GWO, GWEC, September 2022.

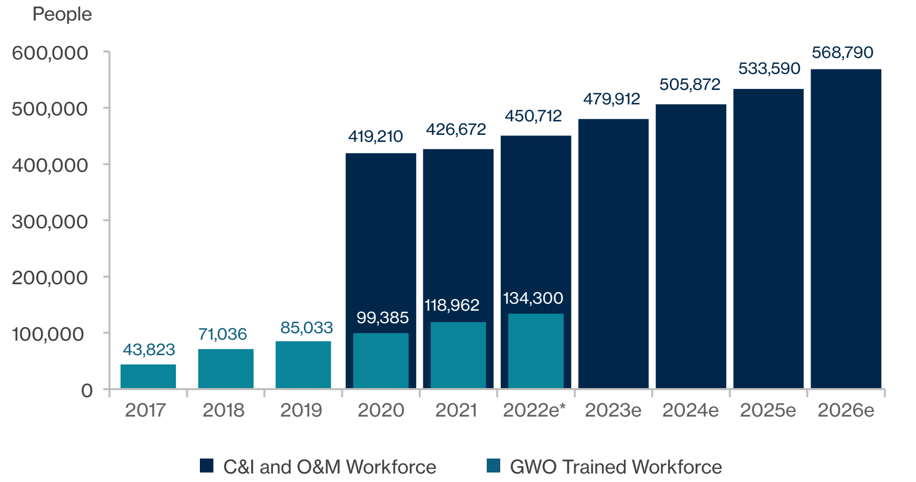
Chapter 4: Global Wind Workforce Outlook, 2022-2026

Drawing from GWEC's wind capacity forecasts and wind project records, the workforce model uses data and assumptions that help estimate the size and forecast the growth of the total number of technicians.

The volume of expected C&I and O&M activity will require new qualified personnel every year, growing the total number of technicians in these segments from 426,700 people in 2021 to 568,800 in 2026.

This represents a call to action for the industry to collaborate with educators and governments to establish local training centres to help develop skilled local workforces.

Figure 5 - The GWO Trained Workforce and the Total Number of Technicians Needed in the C&I and O&M Segments[8]



Annual workforce additions are expected to fluctuate, averaging 28,400 people per year from 2022 to 2026 and resulting in a 36% CAGR from 2021 to 2026.

8 Source: GWO, GWEC, September 2022; * GWO trained workforce figure represents only the first half of 2022.

As of the end of 2021, 119,000 people held at least one valid training certificate in the BST Standard. This means that GWO training covered 28% of the total number of technicians estimated globally. This share is estimated to have increased further to 30% as of the first half of 2022, when active BST certificate holders amounted to 134,300 against a total number of technicians in the C&I and O&M segments estimated at 450,700 people. Increasing the accessibility and use of globally recognised training will be crucial to facilitate technicians' mobility and minimize the need for retraining.

Figure 6 – Share of the Total Estimated Number Technicians Needed for C&I and O&M in 2021[9]

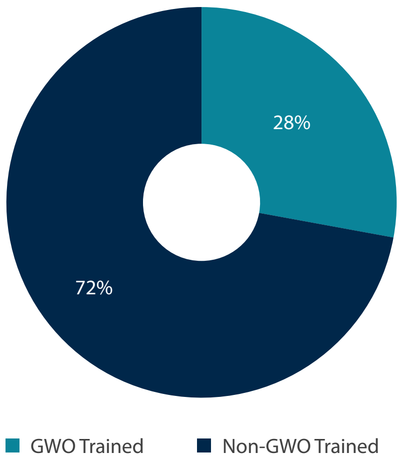
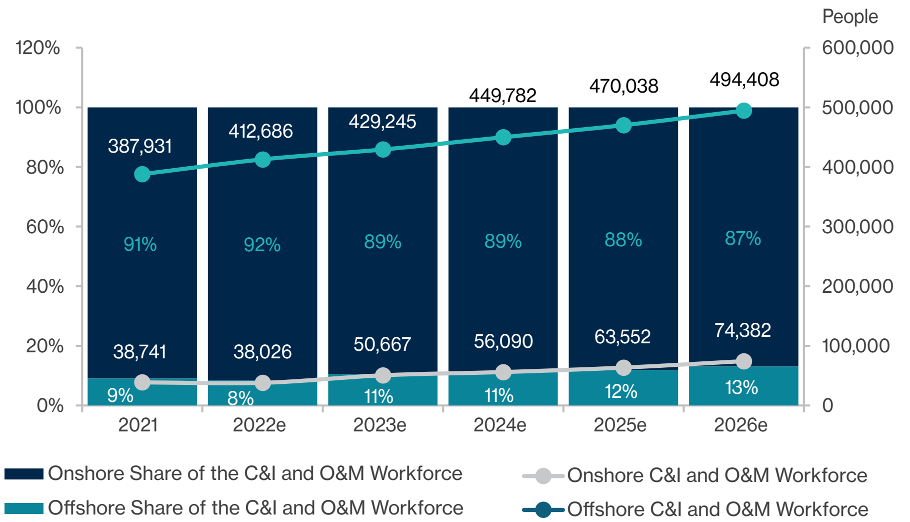


Figure 7 - Annual C&I and O&M Workforce Forecasts, Onshore and Offshore[10]

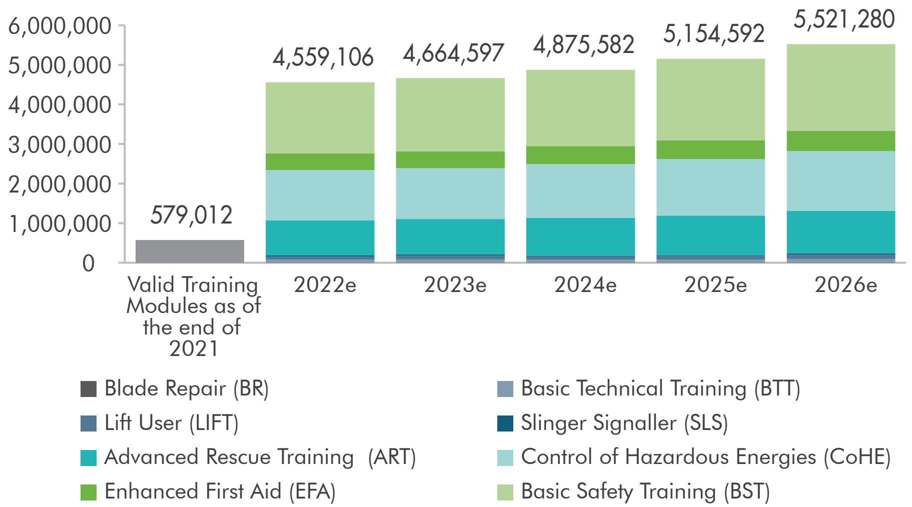


The analysis expects the total number of technicians to grow more rapidly offshore, increasing 92% from 2021 to 2026 compared to 27% onshore within the same timeframe. However, while offshore wind technicians will gain share over the next five years, by 2026 87% of the technicians will still be located onshore, mostly within O&M.

9 Source: GWO, GWEC, September 2022.
10 Source: GWO, GWEC, September 2022.

Based on the annual C&I and O&M workforce forecasts for onshore and offshore, the potential demand for wind technicians training is projected to grow from 4.6 million modules in 2022 to 5.5 million modules in 2026. See the Methodology section on for further information on the scope of training and application.

Figure 8 - Forecast Necessary GWO Training Modules [11]



[11] Source: GWO, GWEC, September 2022.

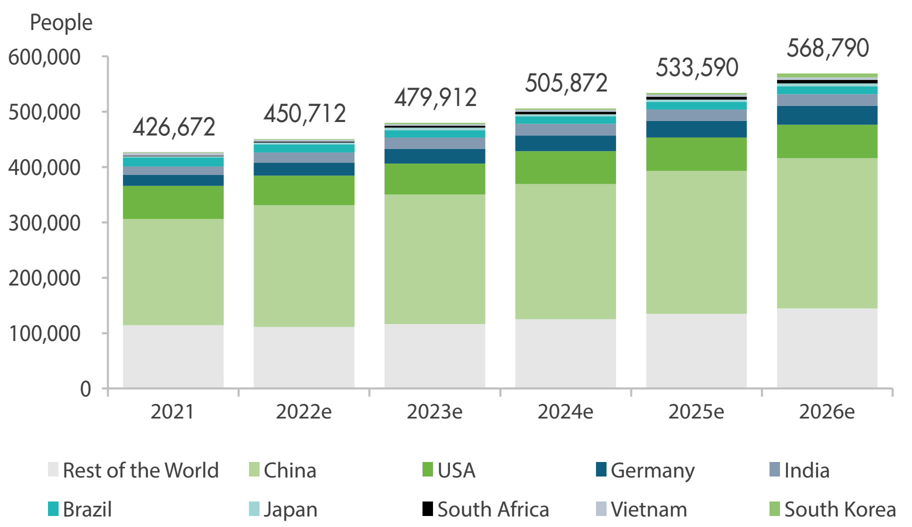
Chapter 5:
Country Commentaries

In addition to the global wind workforce forecast for training needs in the C&I and O&M segments, this report also analyses the training needs specific to nine selected countries: China, USA, Germany, India, Brazil, Japan, South Africa, Vietnam, and South Korea. These countries were selected for regional diversity and market growth: Combined, they represent 75% (417GW) of all new onshore and offshore wind capacity additions expected worldwide from 2022 to 2026.

They include the largest onshore wind markets globally (China, USA, Germany, India), high-growth markets for onshore and offshore wind (Brazil, Japan, Vietnam, and South Korea) and emerging wind markets (South Africa). Together, the training needs in these nine countries account for approximately 75% of the total number of C&I and O&M technicians in 2026 and 86% of the total training development potential projected over the next five years.

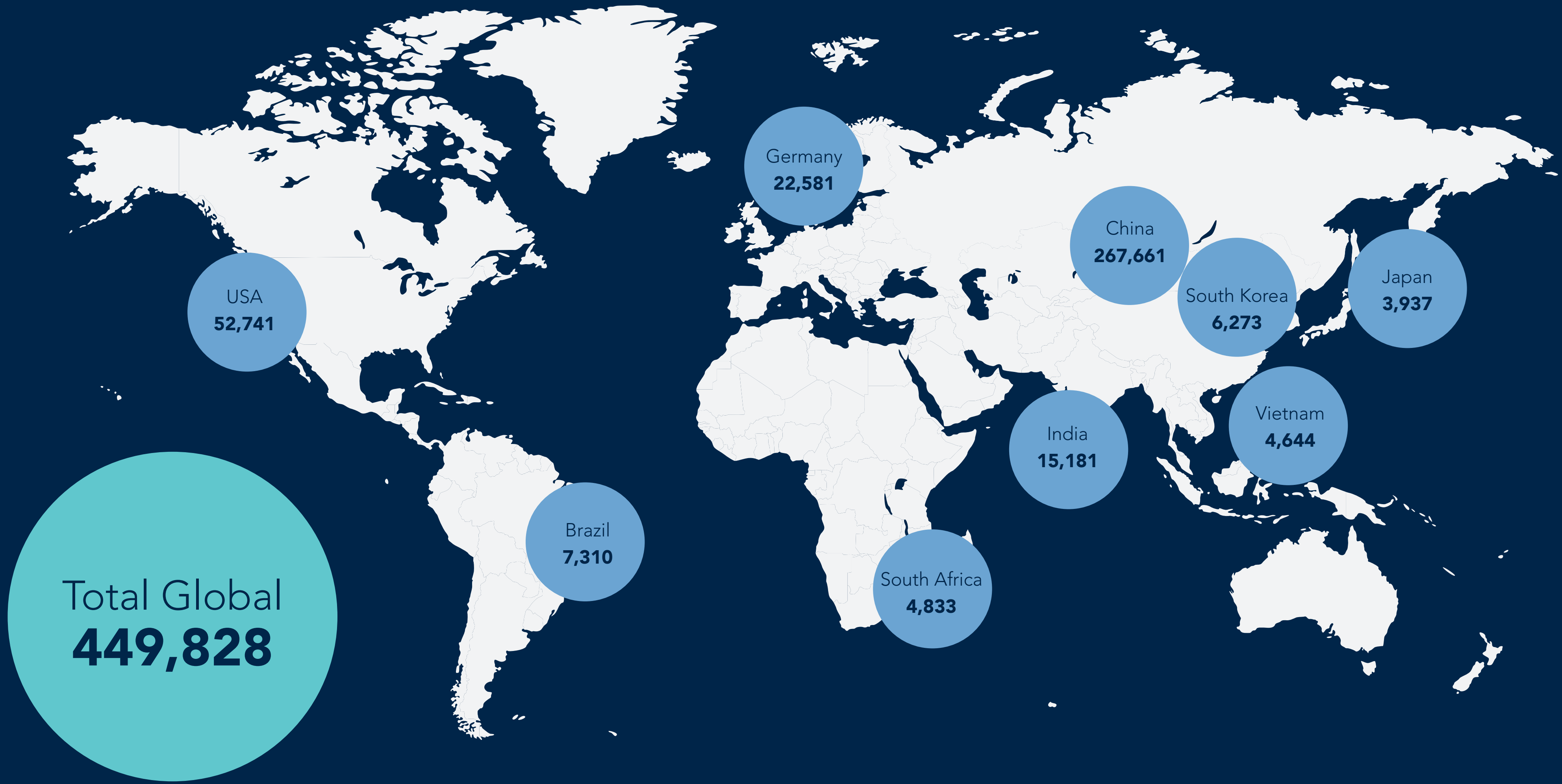
GWO's training providers and educators can potentially extend training to an additional 449,800 people globally from 2022 to 2026.

Figure 9 – Trained C&I and O&M Technicians Needed in Selected Wind Power Countries [12]



[12] Source: GWO, GWEC, September 2022.

Figure 10 - Breakdown of Additional C&I and O&M Wind Technicians Requiring Training for 2022-2026 [13]



[13] Source: GWO, GWEC, September 2022.

The following section outlines the wind market growth outlook, and associated workforce needs analysis, for these nine countries.

USA

As one of the world's leading wind markets, the US has capacity of 134GW of onshore wind and 42MW of offshore wind, as of the end of 2021. The previous year saw some challenges impact the wind sector, from supply chain and logistics bottlenecks to COVID-19 uncertainty, leading to a slowdown in project commissioning and more than 5GW of onshore wind projects with initial commercial operation date (COD) in 2021 delayed to 2022. This growth slowdown also stemmed from the phase down schedule of the production tax credit (PTC), which began expiring for all renewable energy projects beginning construction after 2021.

Still, 2021 marked a record year for offshore wind procurement in the US, with four states awarding 8.4GW, reflecting strong commitment to deliver on state targets and President Biden's federal target of 30GW offshore wind installed by 2030. Hybridisation is also driving wind project development – the US is one of the key markets globally for hybrid projects, with developers bringing more than 4GW of hybrid project capacity online in 2021.

There are a few other key policy drivers which are bolstering the outlook for wind growth in the US. The Biden administration has set a target to reduce greenhouse gas emissions by half from 2005 levels by 2030, to create a carbon-free power sector in the US by 2035 and to reach net zero emissions by 2050. The offshore wind sector is expanding geographically – most recently with 700,000 acres (or 283, 280 hectares) for possible offshore wind development identified in the Gulf of Mexico, traditionally a hub for oil and gas.

Altogether, GWEC Market Intelligence forecasts 42GW of new onshore wind installations in the US from 2022-2026, and 31.5GW of new offshore wind from 2022-2031. The expansion of offshore wind sites – perhaps to the Central Atlantic, Oregon and the Gulf of Maine – could bring upsides to this forecast. The Bureau of Ocean Energy Management (BOEM) has been actively working to identify areas of unexplored wind potential, and this has been paired with fast-paced leasing auctions. For instance, the New York Bight leasing round in early 2022 was the largest offshore wind auction in US history, auctioning around 448,000 acres and 5.6GW of capacity to six bidders. Fixed-bottom offshore wind installations across the US are expected to pick up from 2025 onward.

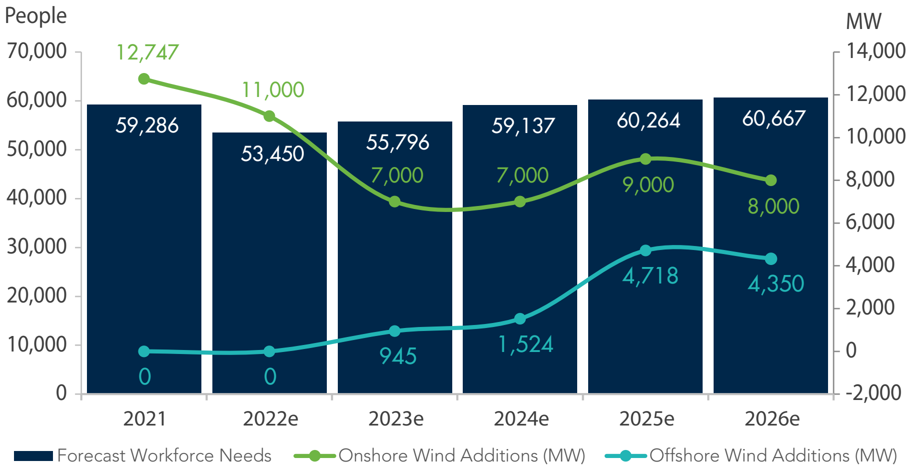
Floating wind and green hydrogen are the next frontiers, with a 3GW floating installation target by 2030 in California and a plan to develop up to 3GW of floating capacity in Oregon by that time. The federal government also issued its first Energy Earthshot challenge framework in 2021, aiming to reduce the cost of green hydrogen to $1/kg, foreseeing a five-fold increase in green hydrogen use if achieved.

To fully capitalise on wind growth, the US will need to resolve some local challenges around supply of balance of plant components, such as cables and foundations, work around Jones Act-related restrictions on vessel use, invest in port upgrades across the country, continue to expand and modernise grid and transmission infrastructure, and form a strategic approach to ensure a domestic workforce is trained for the growing onshore and offshore wind sectors.

Workforce training needs

The workforce trained in GWO standards in the USA more than quadrupled from 1,800 in 2018 to 8,000 at the end of 2021 signalling strong demand amongst leading OEMs and developers. With C&I and O&M technicians estimated at 60,700 people in 2026, in the next five years training providers and educators can train an additional workforce of 52,700 people.

Figure 11 - Onshore and Offshore Wind Additions and the Forecast Workforce Needs for C&I and O&M in the USA [14]



[14] Source: GWO, GWEC, September 2022.

CHINA

For more than a decade, China has held the title of the world's largest market by installed capacity. As of 2021, it also become the world's leading offshore wind market in total installations, surpassing the UK by connecting 16.9GW of new offshore wind installations in a single year – nearly three times the volume of new offshore wind installed worldwide in 2020. This activity was primarily driven by the deadline for projects to access an offshore wind Feed-in Tariff (FiT). In 2021, China also installed more than 30 GW of onshore wind reach grid connection. This brings China's current wind capacity to a huge 310.6GW of onshore wind capacity and 26.4GW of offshore wind capacity, as of the end of 2021.

Supply chain capacity in the country has supported this astounding growth, as China is also the world's largest wind turbine manufacturing hub, accounting for up to 65% of global production of turbine nacelles, gearboxes, generators and blades. There are still around 20 local and three international turbine manufacturers active in the Chinese wind market as of today.

Following the expiration of the wind FiT, the support for renewables in China has shifted to a "grid parity" model where renewable-generated electricity receives the same remuneration as local coal-fired power plants (with the exception of some financial support from some provincial governments through 2025). Under this model, manufacturing and price competition has also increased, reflected in the record-low bidding prices and the series of new and larger turbine models debuted through 2021.

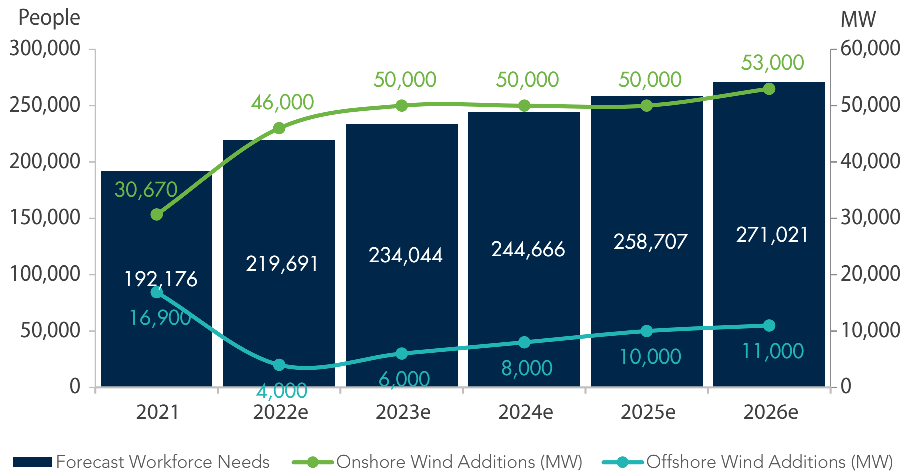
While economics of scale factor into China's impressive wind inventory, growth has also been driven by ambitious policies from central and provincial governments. The Government of China has set a "30-60" target to reach peak emissions by 2030 and carbon neutrality by 2060, supported by a comprehensive plan to accelerate renewable energy. By the end of the current 14th Five Year Plan (2021-2025), renewable energy's share of the increase in primary energy consumption is set to exceed 50%. A number of other supporting policy measures are also in place, including: increasing transmission capacity in northern China; planning at least seven giant onshore wind/solar bases; hybrid projects integrating hydropower, wind and solar power in southwest China; and developing five offshore wind bases (10+GW) in Shandong Peninsula, Yangtze River Delta, Southern Fujian, Eastern Guangdong and Beibu Gulf.

Supported by power market reforms, including the establishment of a unified national electricity market by 2030 with allowance for direct procurement of green electricity, GWEC Market Intelligence reflects a strong forecast for wind growth ahead. As much as 98GW of offshore wind installations is forecast from 2022-2031, while the forecast for onshore wind from 2022-2026 is nearly 250GW.

Workforce training needs

With 3,360 wind technicians holding a valid BST certificate as of the end of 2021, GWO standards have barely scratched the surface of the training needs in the world's largest wind market. The total number of technicians is expected to grow steadily from 192,200 in 2021 to 271,000 people in 2026 fuelled by both onshore and offshore growth.

Figure 12 - Onshore and Offshore Wind Additions and the Forecast Workforce Needs for C&I and O&M in China [15]



[15] Source: GWO, GWEC, September 2022.

JAPAN

Japan has considerable capacity to emerge as one of the wind leaders in East Asia, with 4.5GW of onshore wind and 52MW of offshore wind currently installed. As an archipelago with strong wind technical resource potential (especially for fixed and floating offshore wind, which totals nearly 550GW in territorial waters, according to the World Bank Group), the role of wind power will be vital for supporting the country's energy transition.

With rising fossil fuel costs and a goal to achieve carbon neutrality by 2050, the Government of Japan has recognised wind as a power source that can be introduced at large scale, with significant cost reduction potential and economic benefits. The Sixth Strategic Energy Plan announced in 2021 increased the target share of renewable installed capacity by more than 10% to 36-38% by 2030.

The first large-scale offshore wind farms are scheduled to begin operation in 2022, including the 55MW farm at Akita Port and the 88MW farm at Noshiro Port. But domestic and foreign investor interest in the offshore wind sector is strong since the release of the "Act on Promoting the Utilization of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities" in 2019 and the government's Offshore Wind Industry Vision package released in 2020. Meanwhile, a Green Innovation Fund for Offshore Wind has been established to accelerate next generation technology with a focus on floating offshore wind.

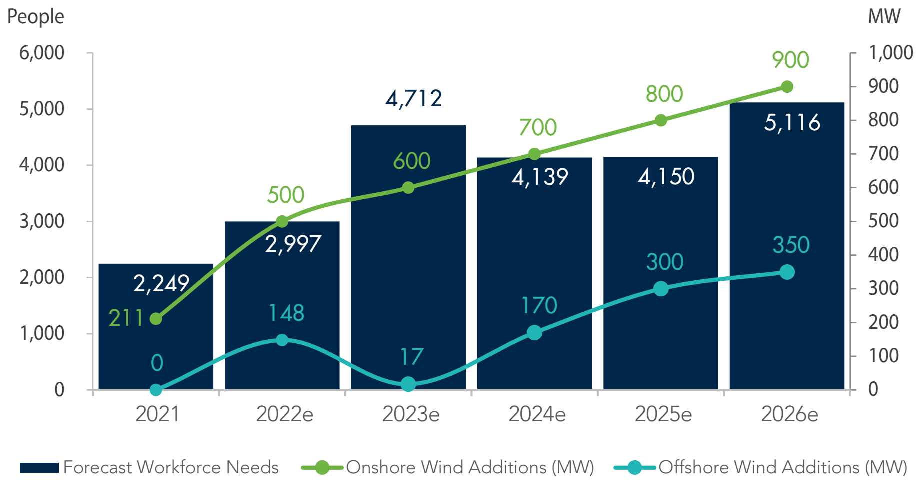
The government has set out to designate 1 GW of promotional zones for offshore wind auction annually for the next 10 years to reach an awarded capacity of 10GW by 2030 and 30-45GW by 2040, including floating offshore wind. But key reforms are needed to ensure on-schedule procurement and completion. A move towards a centralised bidding system will help to increase efficiency of wind surveying, resource measurements, local community surveys and grid access. Sharp lessons also need to be learned from the results of the recent 2021 auction for three fixed-bottom offshore wind projects, each of which was won by consortia led by Mitsubishi Corporation. The auction results left many developers unclear on the pricing and non-pricing criteria assessment, and led to concerns on the time horizons for delivery and bidding procedures. The Government of Japan has heeded industry concerns and postponed the Round 2 auction for Happo-Noshiro zone, which was originally scheduled for mid-2022.

Still, interest and investment remain high in Japan's growing offshore wind sector and its future floating development potential. Onshore wind will also be a key energy source for the country, especially if the bureaucratic on-land environmental and permitting schemes can be streamlined. GWEC Market Intelligence forecasts 3.5GW of new onshore wind installations in Japan from 2022-2026, and 5.8GW of new offshore wind from 2022-2031.

Workforce training needs

The total number of technicians in Japan is forecasted to grow steadily in the next five years, driven heavily by a promising offshore wind market. GWO estimates that by 2026 the C&I and O&M trained workforce can be expanded by 3,900 people in addition to the 1,200 already active as of the end of 2021.

Figure 13 - Onshore and Offshore Wind Additions and the Forecast Workforce Needs for C&I and O&M in Japan [16]



[16] Source: GWO, GWEC, September 2022.

SOUTH KOREA

South Korea has gained strong momentum in offshore wind in recent years, although its onshore wind sector continues to falter, with only 64MW installed in 2021 and 1GW forecasted by GWEC Market Intelligence for the 2022-2026 period. But political commitment to offshore wind is strong and a large pipeline of interest will see around 7.5GW of offshore wind installed over the next 10 years from 2022-2031.

The Green New Deal, announced in 2020, set out a target to achieve net zero emissions by 2050, with a $52 billion green economy investment package. This included $7.7 billion worth of investments in wind, solar and hydrogen technologies by 2025, and the establishment of a major target of 12GW offshore wind by 2030. The country's net zero target was passed in a bill in September 2021.

However, a new administration under President Yoon Suk-yeol, who took office in May 2022, has seen strengthened support for nuclear energy in the Korean power mix to meet the net zero goal. There may be an accompanying reduction of the renewable energy target put into place by the former administration (30% of the power mix by 2030), compared to just over 6% in 2021. Whether this equates to a reduction in the country's onshore and offshore wind targets, or a constraint on government budgets needed for grid/port development for wind integration, remains to be seen.

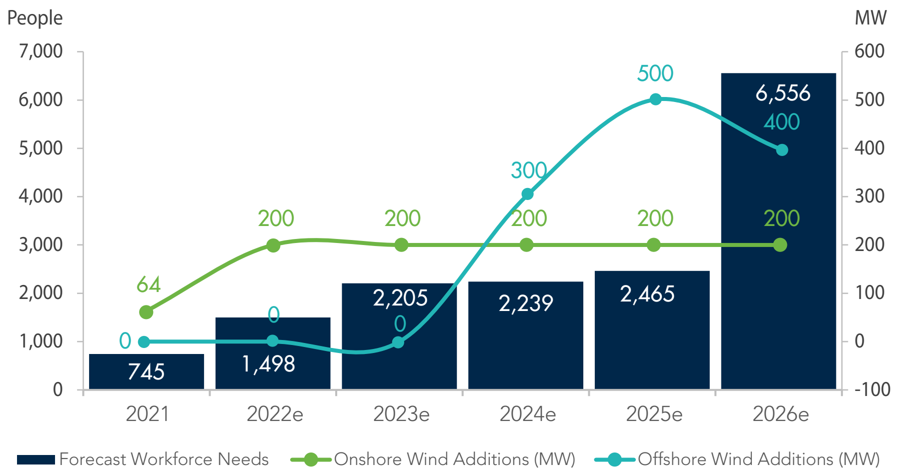
Still, the new administration is seen as investor-friendly, and South Korea has courted strong domestic and foreign investment interest for offshore wind. It announced the world's largest offshore wind project of 8.2GW off the coast of Shinan, which would provide power to 12 million residents in nearby Seoul and Incheon by 2030. The project is being developed by a consortium of 33 public and private entities, including the utility Korea Electric Power Corp (KEPCO) and local OEMs like Doosan Heavy Industries & Construction. In May 2021, the government also announced a 6GW floating offshore wind complex off the coast of Ulsan by 2030, bringing together local and foreign developers.

The 12GW offshore wind target by 2030 is a large leap from the 133MW of offshore wind currently installed, as of the end of 2021. But as much as 25GW of potential capacity which could come online by 2035 has been identified, according to Aegir Analytics. Maximising offshore wind installations at speed in this decade will require resolve to address the overly complex permitting process for wind projects, a degree of local opposition from commercial fishing interests, clarity around the pricing mechanism of Renewable Energy Certificates (RECs) and significant grid reinforcement around North and South Jeolla and Ulsan, where large-scale offshore wind capacity is in development.

Workforce training needs

With stable onshore capacity additions throughout the outlook period, offshore wind will drive a surge in the total number of C&I and O&M technicians needed from 2023 onward. The total number of technicians in these segments in South Korea is expected to peak in 2026 driven by the intense C&I activity required to install the 2GW of offshore capacity scheduled for commissioning across 2027 and 2028. With only 283 people with a valid BST certificate, training providers and educators can train an additional 6,300 people in the next five years.

Figure 14 - Onshore and Offshore Wind Additions and the Forecast Workforce Needs for C&I and O&M in South Korea [17]



[17] Source: GWO, GWEC, September 2022.

VIETNAM

Vietnam is shaping up as a leader of Southeast Asia's energy transition and is currently the largest wind market in the region. The country has installed more than 20GW of renewable energy in the three years between 2019 and 2021, including 4.1GW of wind power. Despite severe supply chain disruptions from the COVID-19 pandemic, Vietnam exceeded expectations to install 3.5GW of new wind capacity in 2021, primarily driven by the rush to meet the November FiT deadline.

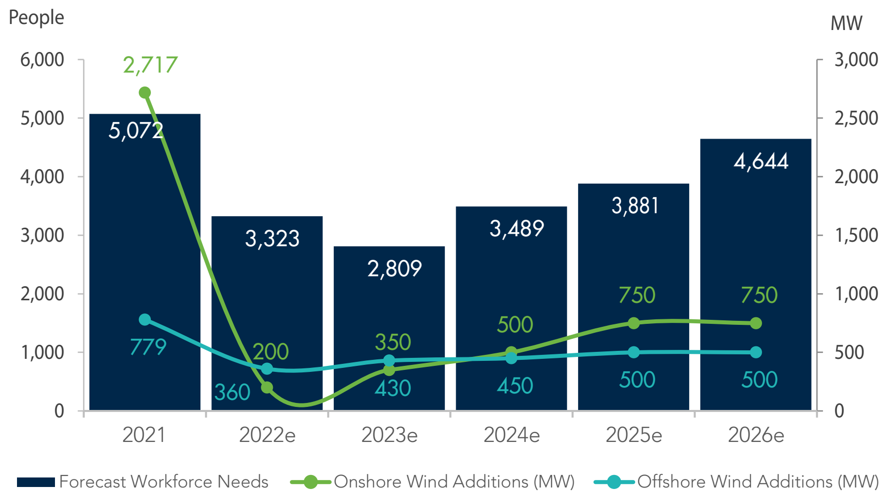
Market growth fundamentals are strong, with attractive technical resources for onshore and offshore wind and high GDP growth and power demand rise forecasted. Although the country is currently dependent on imported fossil fuels, the Government of Vietnam has committed to reach net zero emissions by 2050 and pledged phase out of unabated coal generation by the 2040s. The forthcoming finalisation of the Power Development Plan VIII (PDP8) will also usher in a new era of renewable energy.

Following several rounds of revision, the targets for wind energy in PDP8 have dramatically increased from 2021 to 2022. The latest draft reflects 7+GW of offshore wind targeted by 2030 and 54-74GW by 2045; onshore wind targets are 15-25GW by 2030 and then 43-63GW by 2045. The range of targets will depend on the speed and ambition of the energy transition, and whether challenges around grid and transmission can be resolved and LNG can take a backseat in the energy mix by 2045.

Vietnam will require accelerated and ambitious wind energy deployment to achieve either scenario in PDP8. Studies show that it could even move faster – the World Bank Group has identified as much as 10GW of potential offshore wind capacity which could be installed by 2030. Over the next decade, from 2022-2031, GWEC Market Intelligence estimates 6.8GW of offshore wind will be installed in Vietnam, including a mix of intertidal and true offshore wind projects. From 2022-2026, GWEC Market Intelligence forecasts that more than 2.5GW of onshore wind projects will be installed. This includes a tranche of wind projects which have met delays due to logistics, workforce and supply chain challenges posed by the pandemic.

Some major policy issues need to be resolved in the near term to maximise Vietnam's wind potential, including clarity on procurement and grid access. After the Feed in Tariff (FiT) for wind expired, developers are now negotiating direct agreements with the Ministry of Industry and Trade for a price framework and with state utility EVN for a connection agreement. The country still lacks a clear policy and regulatory framework for offshore wind, including procurement mechanisms and timeline and permitting requirements. Given the present risks in the wind PPA, including challenges around the terms for dispute resolution and curtailment, it will be vital to have a clear route to market for both onshore and offshore wind development.

Figure 15 - Onshore and Offshore Wind Additions and the Forecast Workforce Needs for C&I and O&M in Vietnam [18]



Workforce training needs

The expiry of the FiT at the end of 2021 will lower annual installation activity in 2022 and 2023, with relapses on the workforce needed for onshore construction. However, a healthy combination of onshore and offshore growth will contribute to increasing the total number of C&I and O&M technicians in Vietnam from 2,800 people in 2023 to 4,600 in 2026.

[18] Source: GWO, GWEC, September 2022.

INDIA

India has long been one of the leading wind markets in the world, with more than 40GW of onshore wind installed, and will play a crucial role in determining the pace and pathway of the energy transition in wider Asia. Governments at national and state level have set high ambitions for renewable energy to scale up to meet increasing power demand and industrial expansion across the country. At COP26, the Government of India announced goals to reach 500GW of non-fossil fuels energy capacity by 2030, 50% renewable share in the energy mix by 2030 (up from 38.5% today), reduction of emissions intensity of the national economy by 45% by 2030 and achievement of net zero emissions by 2030. The Ministry of New and Renewable Energy (MNRE) has further targeted 140GW of wind energy capacity installed by 2030, of which 30GW would comprise offshore wind.

The wind market in India has faltered in recent years, facing a slowdown in tendering and installations that was not helped by a series of COVID-19 surges and lockdowns. But progress picked up in 2021, with more than 1.4GW of wind installed during the year and nearly 2.7GW of onshore wind and 1.95GW of hybrid auctions including wind awarded by state and central agencies. The Government of India proactively introduced a blanket time extension to renewables projects, as well as an extension to the waiver of interstate power transmission system (ISTS) charges for renewables projects commissioned by June 2025. Innovative auction models for round-the-clock and hybrid generation have also proved a driver of new wind procurement.

A persistent set of legacy issues around procurement, PPA sanctity, payments from distribution companies, land allocation and grid access, plus increased turbine prices driven by the rise in commodity prices, somewhat dampen the outlook from GWEC Market Intelligence for onshore wind growth from 2022-2026 to 19.4GW – below the level of growth needed to reach 2030 targets.

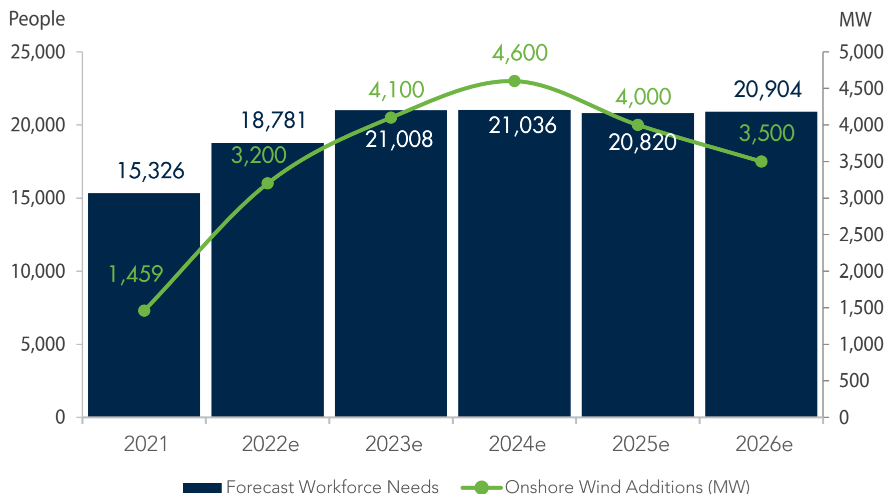
Nevertheless, India is increasingly emerging as a prominent hub for turbine component manufacturing and export in Asia, driven by timely attainment of targets, a strengthened domestic supply chain, ease of doing business with relatively low production and labour costs, as well as concerns around COVID-19 lockdowns and geopolitics in China. This manufacturing capacity could support a higher pace of wind growth if some of the legacy challenges can be resolved. Other potential drivers include greater commitments to renewables from India's public sector undertakings, repowering frameworks for onshore wind, development of green energy corridors to ease grid integration and corporate procurement of renewable energy.

For the successful development of offshore wind and to realise the MNRE's ambitious tender trajectory to bid out 37GW of offshore wind capacity by 2030, an enabling environment and comprehensive state development roadmaps will be needed in Gujarat and Tamil Nadu. GWEC Market Intelligence forecasts the first tranche of offshore wind projects built from 2027 onward, for a total of 3GW installed by 2031. Faster progress and robust policy frameworks will be needed to close the gap to the 30GW offshore wind goal by 2030.

Workforce training needs

The trained C&I and O&M workforce in India is expected to expand 36% from 15,300 people in 2021 to 20,900 in 2026, fuelled primarily by onshore capacity additions. Training providers and educators could train 15,200 people in addition to the 5,700 people with a valid BST certificate as of the end of 2021.

Figure 16 - Onshore Wind Additions and the Forecast Workforce Needs for C&I and O&M in India[19]



[19] Source: GWO, GWEC, September 2022.

BRAZIL

2021 brought challenges to Brazil's wind sector, largely stemming from the COVID-19 pandemic but there is promising growth on the horizon for the leading wind market in Latin America. In 2021, Brazil installed nearly 4GW of wind and reached a milestone of 20GW of installed capacity in the country, equivalent to 55% of all wind power capacity in Latin America. The growth was driven by economic recovery and industry consolidation, especially in the latter half of the year, as well as the strong growth of project development in the so-called bilateral or free market with private PPAs. 2021 also marked the arrival of new frontiers for the wind sector in Brazil, including offshore wind, production of green hydrogen and regulation of hybrid projects.

From 1GW of installed capacity in 2011 to 21GW by January 2022, Brazil has seen wind grow over the last decade to contribute 11% of the total electricity matrix. Wind is now the second-largest source of power generation in the country, after hydropower. Some of the factors that underpin this growth are a series of successful competitive auctions, a focus on national content that has nurtured a solid industrial base for wind energy (manufacturing capacity can produce enough turbines to install around 5GW per year) and changing climatic patterns that have reduced water reservoir levels and increased uncertainty around hydropower generation.

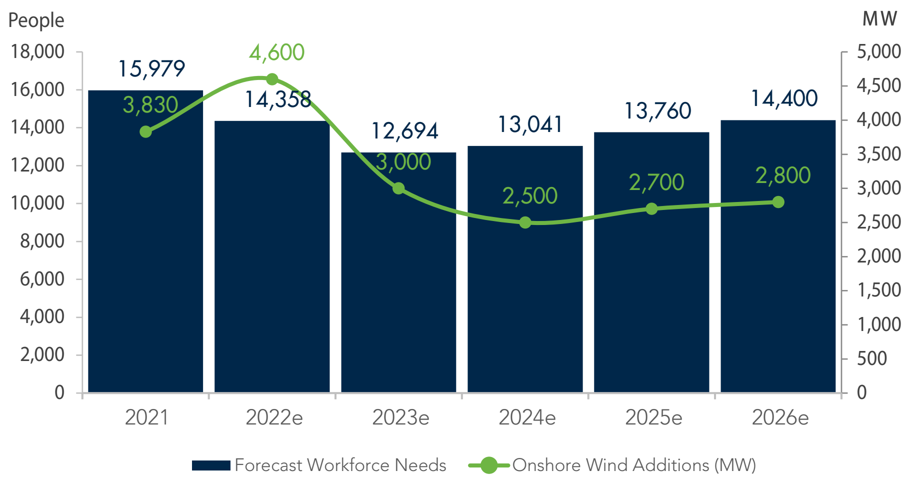
The bilateral market for direct transactions of wind energy has also become a growth driver for new installations. According to the Brazilian Wind Energy Association (ABEEólica), sector investment is expected to reach $5.8 billion in 2022, with up to 5GW in the pipeline for installation this year. For onshore wind, GWEC Market Intelligence forecasts 15.6GW to be installed in the period 2022-2026.

Brazil has also reached a milestone for offshore wind implementation. In early 2022, the long awaited Decree No. 10,946/2022 was published, allowing for the transfer of physical spaces and the use of natural resources to generate electricity from offshore plants. This has sent a positive signal to the market, prompting more than 100GW of offshore wind projects to request licensing by the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA). GWEC Market Intelligence forecasts that the first tranche of offshore wind installations will come online in 2028, with nearly 3GW installed between 2028-2031. The Energy Research Office (EPE) is setting its sights on a 16GW installation target for offshore wind by 2050 and targeting a 20% reduction in CAPEX by that time. To meet these goals, there is work to be done around port upgrades, transmission buildout, increasing public institution resource and advancing the implementation of a "one-stop shop" for permitting, among other regulatory advances.

Workforce training needs

The C&I and O&M workforce in Brazil is expected to decline in 2022 and 2023, driven by weakening onshore wind construction activity in 2023 and 2024. The figures are forecasted to start growing in 2024 towards a trained workforce of 14,400 people in 2026, as onshore installations pick up again in 2025 and companies prepare for the first offshore project scheduled for commissioning in 2028.

Figure 17 - Onshore Wind Additions and the Forecast Workforce Needs for C&I and O&M in Brazil[20]



[20] Source: GWO, GWEC, September 2022.

GERMANY

For several years, the German onshore wind market was in decline, with both new capacity and wind employment reaching a historic low in 2019. Although growth rates for onshore wind have been steadily increasing in the past two years, bringing cumulative onshore wind capacity to 57 GW, offshore wind installation stays low with only 237MW commissioned in 2020-2021. The slowdown was primarily caused by previously unfavourable market conditions and a low level of short-term offshore wind projects in the pipeline. As the end of 2021, 7.7GW offshore wind was installed in Germany.

Under the political impetus of a new administration in 2021 embracing the renewable energy transition, led by Social Democrat Olaf Scholz, and the impacts of the Russian invasion of Ukraine on Germany's energy supply, the prospects for wind growth are dramatically improved in Germany.

Tackling climate change and accelerating renewables deployment are both priorities of the new coalition government, formed between the Social Democratic Party, the Greens and the Liberal Democratic Party. The government has committed to achieving carbon neutrality by 2045, and fully supports delivery of the EU "Fit for 55" programme and affirmed phaseout of nuclear plants, even amid energy security and supply challenges in the wake of Russia's invasion of Ukraine. To reach these goals, 80% of the power mix must be generated by renewables by 2030, scaling up to nearly 100% by 2035.

More ambitious wind targets include 30GW of offshore wind by 2030 and 40GW by 2035, while onshore wind installations should scale up to 12GW annually in the latter half of the decade. A series of policy reforms to achieve these targets have been rolled out since early 2022. This includes increased auctions for renewable energy, and classes the use of renewable energy as in the "overriding public interest", as a means to reduce permitting friction for developers.[21] State governments must now designate 2% of land for wind farms. In addition, Germany has joined Belgium, the Netherlands and Denmark in the "Esbjerg Declaration" to expand North Sea offshore wind capacity 10-fold to at least 150GW by 2050.

Taken altogether, these measures should streamline the permitting process, which currently takes six years for onshore wind, and generate significant cost reduction. However, these measures

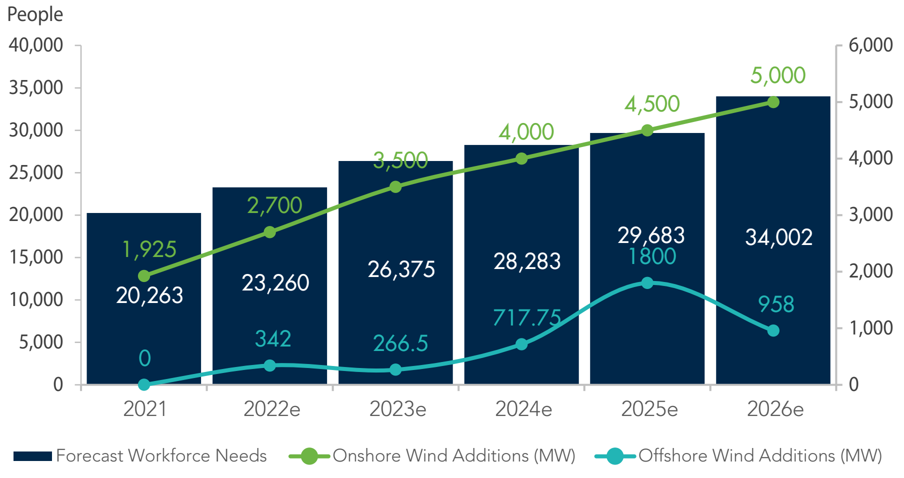
[21] European Commission, REPowerEU, 2022, link.

are unlikely to take effect until at least 2023, and the evolving energy security crisis may yet delay actions – the government has already proposed reactivating coal and oil-fired plants to relieve gas shortages. As such, the GWEC Market Intelligence forecast is only current as of Q1 2022 but foresees additions of 19.7GW onshore wind from 2022-2026 and 20.6GW of offshore wind from 2022-2031.

Workforce training needs

Training providers and educators can potentially train 22,600 additional people in the next five years, both onshore and offshore. The technicians needed in the C&I and O&M segments of Germany's wind market are expected to total 34,000 in 2026 and this will be driven predominantly by a recovery in annual onshore wind additions.

Figure 18 – Onshore and Offshore Wind Additions and the Forecast Workforce Needs for C&I and O&M in Germany [22]



[22] Source: GWO, GWEC, September 2022.

SOUTH AFRICA

South Africa holds the crown as the largest wind market in sub-Saharan Africa, in terms of cumulative capacity, with 3.2GW installed onshore wind. As the third-largest economy and one of the most populous countries on the continent, South Africa is also home to tremendous potential for wind and renewable energy resources. Despite this, its energy mix is largely dependent on fossil fuels, with nearly 90% of electricity generation derived from coal and peat. Wind, the largest clean power resource, provides 3% of the country's power.

In the master strategy document for the energy system, the Integrated Resource Plan (IRP 2019-2030), renewable energy takes on a more primary role in the power mix. The Low Emission Development Strategy in 2020 calls for up to 40% renewable share by 2030, which would require an additional 20GW of capacity in this decade. With only 5.4GW of new onshore wind installations forecast by GWEC Market Intelligence from 2022-2026, growth will need to pick up to meet the 2030 renewables target, let alone to support South Africa's commitment to net zero carbon emissions by 2050.

Commitment to regular and predictable procurement of large-scale renewable energy projects is needed, such as through the Renewable Energy Independent Power Producer Procurement Programme (REI4P), in addition to resolution of barriers. While no large-scale renewable auction was conducted in 2020, two small hybrid projects totalling 160MW were awarded through a 'Risk Mitigation Independent Power Producer Programme' (RMIPP) in 2020, with the winners announced in March 2021.

In January 2021, the government announced plans to launch three new renewable energy auction rounds totalling 6,800MW, with the first round of 2,600MW of wind and solar to be held in January or February 2021, a second round of 2,600 MW in August 2021, and a third round of 1,600MW in January or February 2022. The first round under the REI4P Bid Window 5 in October 2021 attracted bids amounting to nearly four times the capacity awarded, leading to a record 12 wind projects winning 1.6GW of awards with an expectation to reach COD within three years. There is clearly large appetite for wind investment, and the second round under the ongoing 6th window, which was delayed to the summer in 2022, has recently doubled the capacity allocation for wind and solar projects to a total of 5.2GW.

Financial and regulatory challenges restrict state-owned utility Eskom from accelerating renewables integration, and grid modernisation and upgrades are sorely needed, especially in three provinces including the Northern Cape. In addition, the phaseout of coal and support for the coal sector workforce will be critical factors for the future trajectory of the wind sector in the country. Investors and financiers require as much policy certainty as possible, with supportive frameworks which allow for transmission system services and the signing of direct PPAs with IPPs without ministerial approval.

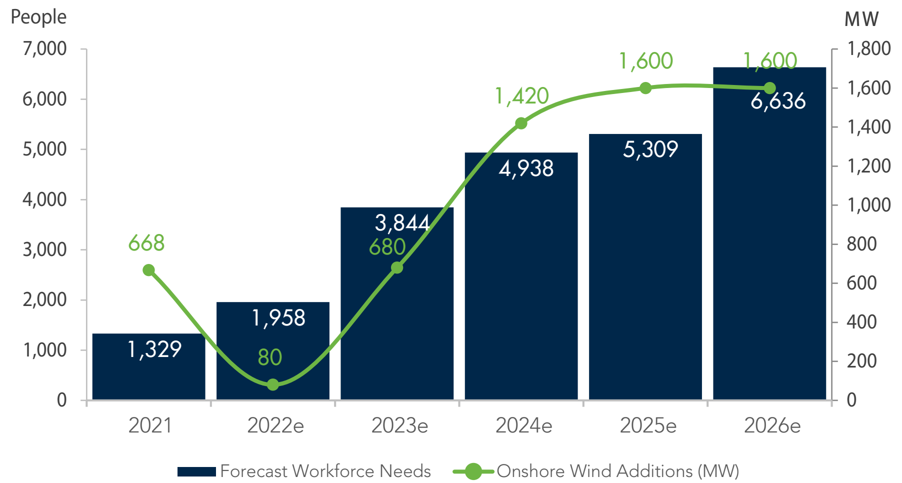
Updated wind resource assessments in provinces like Mpumalanga, historically home to fossil fuel generation and energy-intensive industries, could unlock further deployment. While offshore wind is not foreseen for commissioning within the next decade, South Africa has strong floating offshore wind potential totalling 852GW of resource within its territorial waters, according to the World Bank Group.

[23] Source: GWO, GWEC, September 2022.

Workforce training needs

GWO training for wind technicians in South Africa grew only marginally in 2020 under the combined effect of the pandemic and weaker construction activity but experienced an upturn in 2021. GWO expects that there is potential for more than 4,800 to undergo training to meet intense installation activity until 2026, when 6,600 trained C&I and O&M wind technicians will be needed in South Africa.

Figure 19 - Onshore Wind Additions and the Forecast Workforce Needs for C&I and O&M in South Africa[23]



Chapter 6:
Methodology: The GWO Wind Workforce Forecasting Model

As of the end of 2021, the GWO-trained workforce – the number of individuals with a valid GWO BST certificate – numbered 119,000 people across 50 countries. Nonetheless, the wind energy workforce in scope for GWO training is much larger and is growing rapidly with the increase in wind turbine installations around the world.

As of the end of 2021, the GWO-trained workforce – the number of individuals with a valid GWO BST certificate – numbered 119,000 people across 50 countries. Nonetheless, the wind energy workforce in scope for GWO training is much larger and is growing rapidly with the increase in wind turbine installations around the world.

Since 2019, GWO and GWEC collaborated on creating workforce forecasts for the global wind industry. This report, based on a model developed by RCG and further customized by GWO, shows the potential for the GWO trainable workforce up to 2026 and the potential volume of training that the network of GWO training providers and educators will need to deliver to fully capture the development potential offered by wind industry growth. It also unveils a new methodology to calculate the global construction and installation (C&I) and operation and maintenance (O&M) workforce.

Workforce

The workforce forecasting model builds projections for the total number of technicians needed to support the growth of global wind market. Onshore and offshore forecasts are calculated separately to account for differences in the available input data and the adjustment factors that need to be applied. The same logic applies to C&I and O&M. Thus, GWO has developed four formulas to forecast wind workforce growth, each reflecting the availability of data, and based on the dynamics inherent in each sector and development phase.

The model combines data from GWEC on installed capacity and capacity forecasts with the following elements included in the forecasts: number of projects, number of turbines, turbine rating and, in the case of offshore projects, distance from shore and O&M logistics setup.

These data are combined with inputs[24] on the typical workforce needed on onshore and offshore wind projects:

Construction and Installation (Onshore & Offshore):

GWO's model considers estimates and other data on project construction to calculate the people/turbine ratio in a base year corresponding to plant commissioning. Then, it factors in annual gains in turbine rating to calculate a correction factor that lowers the number of technicians needed on a per-MW basis throughout the outlook period. Using GWEC's and IRENA's "Wind Can Power 3.3 Million New Jobs Over Next Five Years" report published in April 2021, we estimated that the construction and installation of a 50MW onshore wind farm will require 132 full time jobs. This figure rises to 913 full time jobs for the construction and installation of a 500MW offshore wind farm. Based on an assumption for turbine rating (2021 base year), we derived the estimated number of turbines, and consequently the number of people per turbine. Keeping the number of people per turbine constant (i.e. at 8.2 people/turbine in the case of 4MW turbines installed onshore) we added an assumption on the rating of turbines installed every year thus deriving the total number of full time jobs required on a wind farm as turbine rating grows and the number of turbines in the wind farm decreases. The outcome is a coefficient that shows a declining number of people/MW in each year of the outlook period. When multiplied by the capacity installed each year, this coefficient resulted in the forecast of the number of technicians needed for the construction and installation of onshore and offshore wind farms.

[24] GWEC, Wind can power 3.3 million new jobs over the next five years, pp. 6-7. Link.

Given that the model aims at understanding the workforce trainable by GWO training providers, the forecast of the total addressable workforce for onshore construction and installation includes 30% of the MW forecasted for the year ahead and 70% of the MW forecasted for the year under study. For example, if 100MW were to be added in 2022 and another 200MW in 2023, the workforce calculation for 2022 would consider the workforce needed for 30% of the 200MW of 2023 and the 70% of the 100MW of 2022. The expectation is that a minor part (30%) of the construction and installation workforce will be needed one year ahead of the commissioning of the onshore project, while the majority (70%) will be employed during the last months of operations. The same logic applies for offshore construction and installation, but with 30% of the MW forecasted for the year ahead and 70% of the MW forecasted two years ahead under the study.

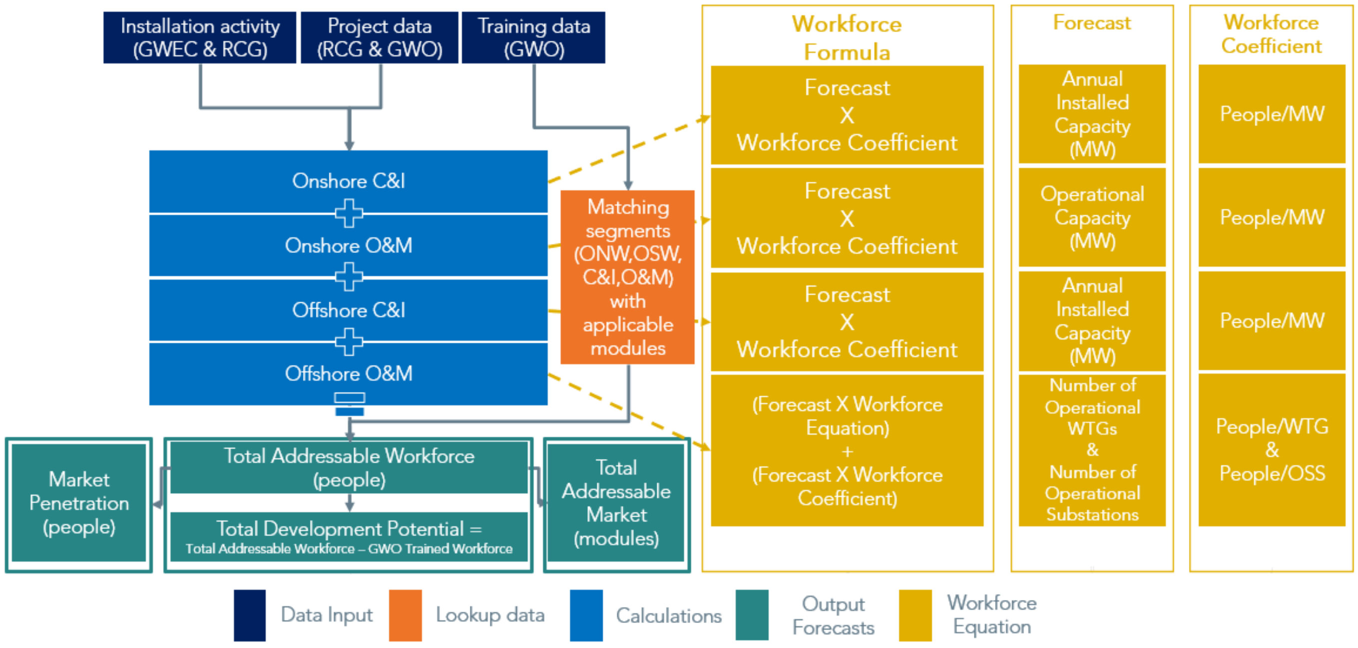
Operation and Maintenance (Onshore):

Using GWEC's and IRENA's "Wind Can Power 3.3 Million New Jobs Over Next Five Years" report published in April 2021, we estimated the operation and maintenance of a 50MW onshore wind farm to require 10 full time jobs. Based on an assumption for turbine rating (2021 base year), we derived the estimated number of turbines, and consequently the number of people involved in servicing each turbine. Keeping the number of people per turbine constant we added an assumption on the rating of turbines installed every year thus deriving the total number of full time jobs required on a wind farm as turbine rating grows and the number of turbines in the wind farm decreases. The outcome is a coefficient that shows a declining number of people/MW in each year of the outlook period. When multiplied by the total capacity operational each year, this coefficient resulted in the forecast of the total number of technicians for onshore operation and maintenance.

Operations and Maintenance (Offshore):

Project level visibility allows the calculation of the forecast for offshore operation and maintenance based on the projected number of turbines and offshore substations. Research on planned projects enables accurate assumptions on the rating and number of turbines that correspond to the capacity expected to be in operation each year throughout the outlook period. The people/turbine coefficient is calculated based on the total expected number of technicians required to be readily available at each site divided by the total number of turbines. The indicator that informs this number is the capacity of the vessels expected to be utilized based on the O&M strategy selected or most likely to be selected by the operator based on project characteristics. This coefficient is a cumulative figure that reflects the installed fleet and thus changes in time based on the characteristics of all the projects that are operational in each given year. This people/turbine coefficient is then multiplied by the total number of operational turbines to complete the first part of the forecast for offshore O&M. The second part of the forecast formula takes into account the additional number of technicians involved in the operation and maintenance of the offshore substation (OSS).

Figure 20 - Summary of the Workforce Forecasting Model



GWO Modules

The second part of the model calculates the potential volume of modules applicable to the number of technicians in scope for GWO training. There are 22 GWO modules in addition to 11 refresher modules (excluding the BSTR-P training standard). Each of those modules corresponds to courses that GWO training providers and educators can be certified to deliver to their course participants. Understanding the development potential of GWO courses can help training providers and educators accelerate their training activity and support workforce safety globally.

The 22 modules have been classified as modules with or without an expiration date, modules for the onshore O&M workforce, modules for the offshore O&M workforce, modules for onshore C&I workforce and modules for the offshore C&I workforce. Although there is no restriction over who can complete GWO courses and obtain certificates, no matter their job and industry, the categorization in groups allowed GWO to estimate a total potential training volume that is consistent with the segmentation used to make the workforce forecasts.

The baseline for calculating the total potential for GWO modules is the total number and breakdown of technicians in scope for GWO training in 2020 and 2021. These figures provide the basis to calculate the refreshers for each year of the outlook period. The modules applicable to each segment (including the refreshers) are applied to each of the outlook's years. The resulting projections conclude that there is a total potential of up to 5.5 million modules (including refreshers) in 2026.

Figure 21 - GWO Training Modules and Their Application

GWO module	Onshore, C&I	Onshore, O&M	Offshore, C&I	Offshore, O&M	Refresher
Blade Repair		x		x	No
Basic Technical Training - Electrical		x		x	No
Basic Technical Training - Hydraulics		x		x	No
Basic Technical Training - Installation	x		x		No
Basic Technical Training - Mechanical	x	x	x	x	No
Lift Commission and Inspection	x	x	x	x	No
Lift Commission, Inspection, Installation and Maintenance	x	x	x	x	No
Lift User	x	x	x	x	No
Slinger Signaller	x	x	x	x	No
Single Rescuer - Hub, Spinner & Inside Blade	x	x	x	x	No
Single Rescuer - Nacelle, Tower, Basement	x	x	x	x	No
Advanced Rescue Training – Hub Rescue	x	x	x	x	Yes
Advanced Rescue Training - Nacelle, Tower & Basement Rescue	x	x	x	x	Yes
Basic Safety	x	x	x	x	Yes
Enhanced First Aid	x	x	x	x	Yes
Electrical Safety	x	x	x	x	Yes
First Aid	x	x	x	x	Yes
Fire Awareness	x	x	x	x	Yes
Manual Handling	x	x	x	x	Yes
Pressure Fluid Safety	x	x	x	x	Yes
Sea Survival			x	x	Yes
Working at Heights	x	x	x	x	Yes
TOTAL	**18**	**20**	**19**	**21**	

Limitations

Although this workforce forecasting model is an upgraded version of the previously developed models, the assumptions embedded in the model have limitations that influence the final outcomes. Firstly, the workforce considered in the model accounts only for GWO trainable professionals within the O&M and C&I phases of onshore and offshore wind project development. Thus, the workforce active in other phases of project development is not considered in the forecasts. Secondly, given the evolving dynamics of the wind power market, wind installation forecasts are inherently prone to upgrades and downgrades and may result in a different outcome from that forecast in this report. Consequently, the assumptions for the calculation of the workforce equations may be impacted by forecast updates.

GWO and GWEC are confident that this new workforce forecasting model will help the industry to better understand the size of the C&I and O&M workforce, and stimulate further discussions and research on this topic. The model will be refined on an ongoing basis to build-in more granular, country and industry specific project data, thus progressively reducing the degree of uncertainty in the results.

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