



TVET SKILLS FOR RENEWABLE ENERGY AND GREEN HYDROGEN IN NAMIBIA

Annexure 3: Wind Turbine Installation and Maintenance

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ACRONYMS

ART	Advanced Rescue Training
BRT	Blade Repair Training
BST	Basic Safety Training
BTT	Basic Technical Training
CO ₂	Carbon Dioxide
CoHE	Control of Hazardous Energy
EFA	Enhanced First Aid
GH ₂	Green Hydrogen
GW	Gigawatt
GWO	Global Wind Organisation
HV	High-Voltage
IRATA	Industrial Rope Access Trade Association
LOTO	Lockout/Tagout
MW	Megawatt
NIMT	Namibia Institute of Mining and Technology
NTA	Namibia Training Authority
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
PtX	Power to X
RE	Renewable Energy
SCADA	Supervisory Control and Data Acquisition
ToT	Training of Trainers
TVET	Technical and Vocational Education and Training
VTC	Vocational Training Centre

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ANALYTICAL REPORT

1.1 Status Quo – Overview of Existing Training Measures and Training Providers

In Namibia, wind energy technology will be crucial in the green hydrogen (GH₂) economy. Installing and maintaining wind turbines is essential to ensure energy production for hydrogen generation. There is a growing demand for qualified Wind Turbine Technicians due to the emerging industries in the renewable energy (RE) and GH₂ sectors. Currently, there are no training centres in Namibia specifically addressing the requirements of wind energy technology. Many technicians within the industry obtain their skills through practical experience or informal training within companies. However, this poses risks regarding workplace safety, efficiency, and compliance with international standards.

The Namibia Training Authority (NTA), responsible for Technical and Vocational Education and Training (TVET) in Namibia, has not yet developed specific training programs for Wind Turbine Technicians. While general technical training courses like Electrical Engineering (Electrical General and Electrical Energy), Fitting and Turning, Automotive Mechatronics, Instrumentation and Control exist, they are not structured to meet the specific needs of the wind energy industry. Developing tailored programs focusing on wind turbines' installation, maintenance, and safety would be essential to enhance workforce qualifications and align with international standards.

To further understand the situation in Namibia, interviews were conducted with training institutions and key industry players. Research was conducted on the qualifications offered by the various vocational training centres (VTCs) to see which qualifications align closely with the wind industry's requirements.

1.2 Stakeholder Mapping and Needs Analysis

Namibia is becoming a major player in the RE and GH₂ sector. Various companies and projects in these sectors are expected to have an increased need for Wind Turbine Technicians, especially in connection with the transport of equipment and materials, assembly of wind turbines and the long-term maintenance of these projects. An overview of relevant stakeholders is outlined below:

Daures Green Hydrogen Village: This project aims to establish a climate-neutral settlement near Brandberg in the Erongo region. The plan includes the production of GH₂ using wind and solar energy, as well as the manufacturing of ammonia and fertilisers for local use.

Hyphen Hydrogen Energy: Hyphen Hydrogen Energy is a Namibian company selected as the government's preferred partner for a large-scale hydrogen project. The plan is to build an electrolysis plant with a capacity

of three gigawatts (GWs) and corresponding wind and solar energy plants with a capacity of five GWs. The aim is to produce around 300,000 tonnes of GH₂ per year. This project requires extensive transportation of heavy goods for the construction and maintenance of the plants.

InnoVent: InnoVent is a French company specialising in wind and solar energy. It operates multiple wind farm projects to support Namibia's RE production. The company plans to expand its capacity further to ensure a stable supply of green electricity for hydrogen production.

NamPower: NamPower is Namibia's state-owned energy supplier. In collaboration with Chinese companies, China Jiangxi International Economic and Technical Cooperation Co. Ltd, and Chint New Energy Development (Zhejiang) Co. Ltd, NamPower is developing the country's largest solar power plant with a capacity of 100 megawatts (MWs). This project aims to reduce Namibia's dependence on electricity imports and stabilise energy prices.

Technicians must demonstrate competence in a multitude of skills and cannot specialise in only one field.

The nature of the work requires technicians to be skilled in the following:

Mechanical Maintenance and Repair: Ability to service and repair turbine components such as gearboxes, generators, and braking systems.

Electrical Knowledge: Understanding of electrical systems, circuits, and high-voltage installations.

IT Skills: Expertise in computer operations, software applications, networking, and programming.

Hydraulics and Pneumatics: Experience with hydraulic and pneumatic control systems.

Fundamentals of Wind Energy: Knowledge of wind turbine operations, aerodynamics, and energy conversion.

Integration with Hydrogen Production: Understanding how wind power is linked to electrolyzers for GH₂ production.

Grid Connection and Energy Storage: Expertise in battery storage, Power-to-X (PtX) technologies, and grid stability.

Working at Heights and Rope Access: Safe operation at over 100 meters using protective equipment.

Fire Protection and Emergency Management: Knowledge of fire prevention, first aid, and evacuation protocols.

Hazardous Materials Handling: Safely handling lubricants, coolants, and other potentially dangerous substances.

SCADA and Remote Monitoring: Ability to use SCADA (Supervisory Control and Data Acquisition) systems for remote wind farm maintenance.

Troubleshooting and Diagnostic Tools: Experience with sensor data, thermography, and vibration analysis for fault detection.

Data Analysis and Reporting: Ability to interpret operational data and develop efficient maintenance strategies.

Communication Skills: Clear reporting and collaboration with engineers, operations managers, and fellow technicians.

1.3 International Benchmarking in relation to Wind Turbine Technology

Wind turbine technicians require specialised training and additional qualifications to work on modern wind energy systems, particularly large-scale projects and offshore installations. This includes certifications in electrical safety, high-voltage work, working at heights, and compliance with industry-specific standards such as GWO (Global Wind Organisation) training.

Within Europe and other countries, wind turbine technicians are primarily trained through vocational training programs, industry partnerships, and in-house training by turbine manufacturers.

Certification is usually provided through industry organisations such as the GWO, the Industrial Rope Access Trade Association (IRATA), or national certification systems. However, there is a lack of standardised, globally recognised certification for advanced troubleshooting, digital diagnostics, and hybrid energy integration. Many technicians receive specialised training directly from wind turbine manufacturers, making cross-certification between different turbine brands a challenge.

Essential knowledge includes the physical principles of wind turbine operations (e.g., aerodynamics, mechanical stresses) and the safe handling of turbine components, including blades, nacelles, and tower segments. A comprehensive understanding of gearbox maintenance, hydraulic systems, and high-voltage (HV) electrical systems is also required.

Technicians working at heights of over 100 meters require specialised climbing and rescue techniques. Familiarity with personal protective equipment (PPE), fall protection systems, and emergency evacuation procedures ensures safety during maintenance and repair work.

Technicians must also be trained in wind turbine control systems, including SCADA, troubleshooting software, and predictive maintenance tools. Experience in diagnosing turbine faults, blade inspections, and gearbox lubrication systems is essential for minimising downtime and optimising performance.

The following regulations and certifications are key for international training and certification:

GWO Basic Safety Training (BST): Mandatory for most wind turbine technicians, covering: working at heights, fire awareness, manual handling, and first aid.

GWO Basic Technical Training (BTT): Covers mechanical, hydraulic, and electrical systems in wind turbines.

IEC 61400: International standards for wind turbine design and safety.

ISO 45001: Occupational health and safety management for wind turbine workers.

IRATA Certification: Rope access training for technicians working on blades and offshore turbines.

1.4 Skills Gap Analysis in the Field of Wind Turbine Technicians

The wind energy sector in Namibia is growing steadily, but there is a lack of specialised training programs for wind turbine technicians. Despite the increasing importance of this sector, there are no comprehensive training programs that specifically prepare professionals for the unique requirements of wind turbine installation, maintenance, and repair. While general technical training courses exist, they do not cover the essential content needed for the wind energy industry.

Lack of Training Content in Wind Turbine Installation and Commissioning

There are no standardised training courses on wind turbine installation and commissioning in Namibia. Technical education programs cover basic electrical and mechanical concepts but do not address the specific requirements of wind power systems.

Missing content:

- ▶ Assembly and alignment of tower segments
- ▶ Installation of the nacelle and generators
- ▶ Installation and adjustment of rotor blades
- ▶ Wiring and electrical connections
- ▶ Safety techniques for working at height
- ▶ Testing and calibration procedures for commissioning

Effects of the shortcomings: Without proper training, there is an increased risk of installation errors, safety violations, and inefficient turbine operation.

Lack of Knowledge in Maintenance and Fault Diagnosis

Technicians in Namibia have limited access to specialised training for wind turbine maintenance and fault diagnosis.

Missing content:

- ▶ Inspection and maintenance of mechanical components (gearboxes, rotor blades, bearings)
- ▶ Diagnosis and repair of electrical faults
- ▶ Software-based troubleshooting and data analysis
- ▶ Working with hydraulic systems in wind turbines
- ▶ Replacement of principal components (e.g., generator, gearbox)

Effects of the shortcomings: A lack of well-trained technicians leads to more extended downtimes, higher maintenance costs, and potential safety risks.

Occupational Safety and Rescue Techniques for Wind Turbine Technicians

General safety training is available, but specialised courses for working on wind turbines are lacking.

Missing content:

- ▶ Fall protection and personal protective equipment
- ▶ Emergency rescue from great heights
- ▶ Evacuation strategies in case of fire, technical failure or personal injury
- ▶ Working in extreme weather conditions
- ▶ First aid measures for high-altitude work

Effects of the shortcomings: Inadequate safety training increases the risk of serious workplace accidents and delays emergency rescue operations.

Handling of Specialised Tools and Lifting Equipment

Namibian technical personnel do not receive specialised training in the use of tools and lifting equipment for wind turbines.

Missing content:

- ▶ Use of torque wrenches and specialised tools
- ▶ Crane operation for replacing large components
- ▶ Use of hoists and lifting devices
- ▶ Precise alignment of rotor blades and gearbox components

Effects of the shortcomings: Without training, there is a higher risk of damage to critical components and accidents due to improper handling and inefficient repair processes.

Conclusion

To further develop Namibia's wind energy sector, it is essential to introduce specialised training programs for wind turbine technicians. These programs should be practical and comprehensively cover safety, maintenance, and installation techniques to ensure efficiency and safety in this sector.



2

RECOMMENDATIONS FOR TRAINING MEASURES IN THE WIND TURBINE TECHNICIAN FIELD

The training programs in wind turbine maintenance and technology are designed for professionals who wish to further their qualifications in the wind energy sector. These programs aim to provide in-depth technical knowledge and practical skills required for the operation and maintenance of wind turbines.

The courses cover key topics such as electrical systems, mechanical and hydraulic components, and control systems, combining theoretical foundations with practical exercises.

A key component of the training content is the course module on the fundamentals of electrical engineering in wind turbines. Here, participants learn the essential principles of electrical systems in wind power plants, from troubleshooting to applying safety standards.

Another core module focuses on the mechanical and hydraulic systems of wind turbines, emphasising the maintenance and fault diagnosis of components such as gearboxes, rotor bearings, and hydraulic systems. Participants acquire the necessary knowledge to identify and address mechanical issues. A course on control systems, communications, and programming provides controllers with expertise in automation technology, including programming controllers and diagnosing faults in wind turbine systems.

The training is designed to be practically oriented, with theoretical lessons complemented by extensive hands-on exercises. Participants can work with real turbine components and directly apply their knowledge, preparing them for the daily tasks in the wind energy industry. Additionally, there is a strong focus on safety standards and emergency management, ensuring that participants are prepared for any situation during wind turbine maintenance and repair.

Trainers conducting these courses possess extensive expertise and practical experience in the wind energy sector. They are capable of communicating complex technical content effectively and helping trainees integrate new knowledge into the application.

The training adopts a hands-on approach, where participants are actively engaged in the learning process. In addition to knowledge transfer, the focus is on developing practical skills crucial for daily work. The courses include both theoretical examinations and practical assessments to evaluate learning outcomes and ensure that all participants acquire the necessary competencies.

A well-equipped infrastructure is necessary to conduct the training. This includes modern classrooms equipped with presentation tools such as projectors and computers, and specialised workshops for practical exercises.

These workshops are furnished with the tools and equipment required for working on wind turbines, including the maintenance of mechanical, hydraulic, and electrical systems. For safety training, adequate facilities are needed to simulate in-tower scenarios, and all necessary safety

equipment is required for the training, such as personal fall protection gear, first-aid stations, and emergency management systems.

Wind energy plays a significant role in the global energy transition and specifically in the context of GH₂ production. In countries like Namibia, which have excellent wind resources, wind power is increasingly used to produce GH₂. Wind energy allows the generation of CO₂-free electricity, which is needed for water electrolysis to produce hydrogen.

Projects are being developed in Namibia where wind turbines are installed to generate GH₂. This hydrogen is intended to meet local energy demands and production for export. In this context, training skilled professionals who can operate and maintain the wind turbines is of central importance. Therefore, the training programs in wind turbine maintenance are most relevant in international markets, especially for countries investing in RE development and GH₂.

In summary, the training programs provide a practical-oriented education that imparts technical expertise and prepares participants for the practical demands of operating wind turbines. This training is of growing importance, especially in light of the global development of wind energy and the use of GH₂ as a sustainable energy source. Therefore, the ability to operate wind turbines safely and efficiently is a key competence for the success of the global energy transition.

The following section describes the recommended short courses needed to address the gaps as identified above.

The recommendation is that international courses be adopted as per Priority 1. Priority 1 can be implemented by bringing trainers to Namibia from abroad or by developing local training capacity and training centres. Priority 2 is listed as an alternative to establish local courses within Namibia, with local certifying bodies, trainers and curricula.

2.1 Priority 1: Global Wind Organisation Training Modules

To enable technicians to work inside a wind turbine, they must complete the following courses. These courses are useless in isolation and must be completed to prepare technicians sufficiently for the working environment.

Enhanced First Aid Training (EFA)

The aim is for the course participants to administer advanced first aid, including lifesaving measures and medical assistance in remote areas, using specialised equipment and teleconsultation.

Course Description: This advanced training course provides participants with the knowledge and skills to administer lifesaving first aid in emergencies, especially in remote locations. The course covers enhanced

first aid techniques, medical teleconsultation, and the use of advanced emergency equipment. Through practical exercises and simulations, participants will develop the competence to provide immediate and adequate medical assistance.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

Understand fundamental and advanced first aid principles:

- ▶ Basic life support and CPR techniques
- ▶ Managing severe bleeding, fractures, and burns
- ▶ Recognising and treating medical emergencies (shock, hypothermia, stroke)

Use advanced emergency equipment:

- ▶ Defibrillators (AED) and advanced wound care materials
- ▶ Telemedical consultation for remote assistance
- ▶ Administration of oxygen therapy

Apply first aid in remote environments:

- ▶ Emergency response strategies in offshore and isolated locations
- ▶ Safe patient handling and transport
- ▶ Communication with emergency services and medical teams

Total estimated duration: 3 days

Theoretical instruction: 1.5 days (12 hours)

Practical exercises: 1.5 days (12 hours)

At the end of the course, participants will complete both a theoretical and a practical examination.

Target Audience:

- ▶ Wind industry professionals working in remote locations
- ▶ Technicians and engineers operating in offshore and onshore wind farms
- ▶ Individuals responsible for health and safety in the wind energy sector

Certification: Upon successful completion, participants will receive the GWO Enhanced First Aid (EFA) Certificate, valid for two years.

Service Lift Training

The aim is for the course participants to safely and efficiently operate and use service lifts in wind turbines, ensuring proper procedures and emergency response.

Course Description: This course provides participants with essential skills and knowledge to safely operate and use service lifts in wind turbines. The training covers lift operation procedures, emergency protocols, and safety measures for working at heights. Hands-on training ensures that participants can effectively use service lifts under real-world conditions.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

Understand service lift operation and safety:

- ▶ Correct use of control panels and emergency stop mechanisms
- ▶ Inspection and daily maintenance of service lifts
- ▶ Load capacity and weight distribution principles

Implement emergency procedures:

- ▶ Safe evacuation in case of lift malfunction
- ▶ Rescue techniques for stranded workers
- ▶ Coordination with rescue teams and emergency services

Work safely at heights:

- ▶ Use of fall protection equipment
- ▶ Compliance with wind industry safety regulations

Total estimated duration: 2 days

Theoretical instruction: 1 day (8 hours)

Practical exercises: 1 day (8 hours)

Participants will complete a final examination, including both theoretical and practical components.

Target Audience:

- ▶ Wind turbine technicians and maintenance personnel
- ▶ Engineers and safety officers in the wind industry

Certification: Upon successful completion, participants will receive a Service Lift Operation Certificate, valid for two years.



Advanced Rescue Training (ART)

The aim is for the course participants to perform complex rescue operations from different parts of a wind turbine, using advanced rescue techniques and equipment.

Course Description: This intensive training course provides wind industry professionals with the necessary skills to perform complex rescue operations inside wind turbines. The course covers advanced rescue techniques across various turbine locations, including the nacelle, hub, and tower. Participants will engage in realistic simulations to ensure competence in high-risk scenarios.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

Perform advanced rescue operations in confined spaces:

- ▶ Rescue from nacelle, tower, and hub
- ▶ Use of specialised rescue equipment
- ▶ Coordination with emergency response teams

Apply safe working techniques at height:

- ▶ Rope access methods and self-rescue skills
- ▶ Risk assessment and emergency planning

Handle emergency scenarios:

- ▶ Injured worker extraction techniques
- ▶ Evacuation during fire, structural failure, or medical emergencies

Total estimated duration: 4 days

Theoretical instruction: 2 days (16 hours)

Practical driving exercises: 2 days (16 hours)

At the end of the course, participants will complete a theoretical and practical examination.

Target Audience:

- ▶ Wind turbine technicians and maintenance personnel
- ▶ Health and safety officers in the wind industry

Certification: Upon successful completion, participants receive the GWO Advanced Rescue Training (ART) Certificate, valid for two years.

Basic Safety Training (BST)

The aim of the course is for the participants to develop fundamental safety skills for working in the wind industry, including first aid, fire awareness, working at heights, manual handling, and sea survival.

Course Description: This course provides fundamental safety training for individuals working in the wind energy sector. It includes modules on first aid, fire awareness, manual handling, working at heights, and survival at sea. The training is essential for ensuring a safe working environment in both onshore and offshore wind farms.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

- ▶ Apply safety procedures in wind turbine environments
- ▶ Perform first aid in case of workplace accidents
- ▶ Respond to fire hazards and use firefighting equipment
- ▶ Safely work at heights and use fall protection equipment
- ▶ Conduct manual handling tasks to reduce injury risks

Total estimated duration: 5 days

Theoretical instruction: 2.5 days (20 hours)

Practical exercises: 2.5 days (20 hours)

Participants will complete both a theoretical and a practical examination.

Target Audience:

- ▶ Wind turbine technicians and maintenance personnel
- ▶ Health and safety officers in the wind industry

Certification: Upon successful completion, participants receive the GWO Basic Safety Training (BST) Certificate, valid for two years.

Basic Technical Training (BTT)

The aim is for the course participants to gain essential technical knowledge in mechanics, hydraulics, and electricity, enabling them to perform basic maintenance and troubleshooting on wind turbines.

Course Description: This course provides fundamental technical training for individuals entering the wind energy sector. It covers key concepts in mechanics, electricity, and hydraulics to prepare participants for technical roles in wind turbine maintenance and operation.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

- ▶ Understand basic mechanical systems in wind turbines
- ▶ Perform electrical safety procedures and troubleshooting
- ▶ Work with hydraulic systems in wind energy applications
- ▶ Perform tower assembly with high torque tools

Total estimated duration: 5 days

Theoretical instruction: 2.5 days (20 hours)

Practical exercises: 2.5 days (20 hours)

Participants will complete both a theoretical and a practical examination.

Target Audience:

This course is designed for:

- ▶ Wind turbine technicians and maintenance personnel
- ▶ Health and safety officers in the wind industry

Certification: Upon successful completion, participants receive the GWO Basic Technical Training (BTT) Certificate.

Blade Repair Training (BRT)

The aim is for the course participants to acquire the necessary skills to inspect, maintain, and repair wind turbine blades, ensuring structural integrity and performance.

Course Description: This course teaches participants how to inspect, maintain, and repair wind turbine blades to ensure optimal performance and longevity.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

- ▶ Conduct blade damage inspections
- ▶ Apply composite repair techniques
- ▶ Work safely with blade maintenance tools\

Total estimated duration: 5 days

Theoretical instruction: 2.5 days (20 hours)

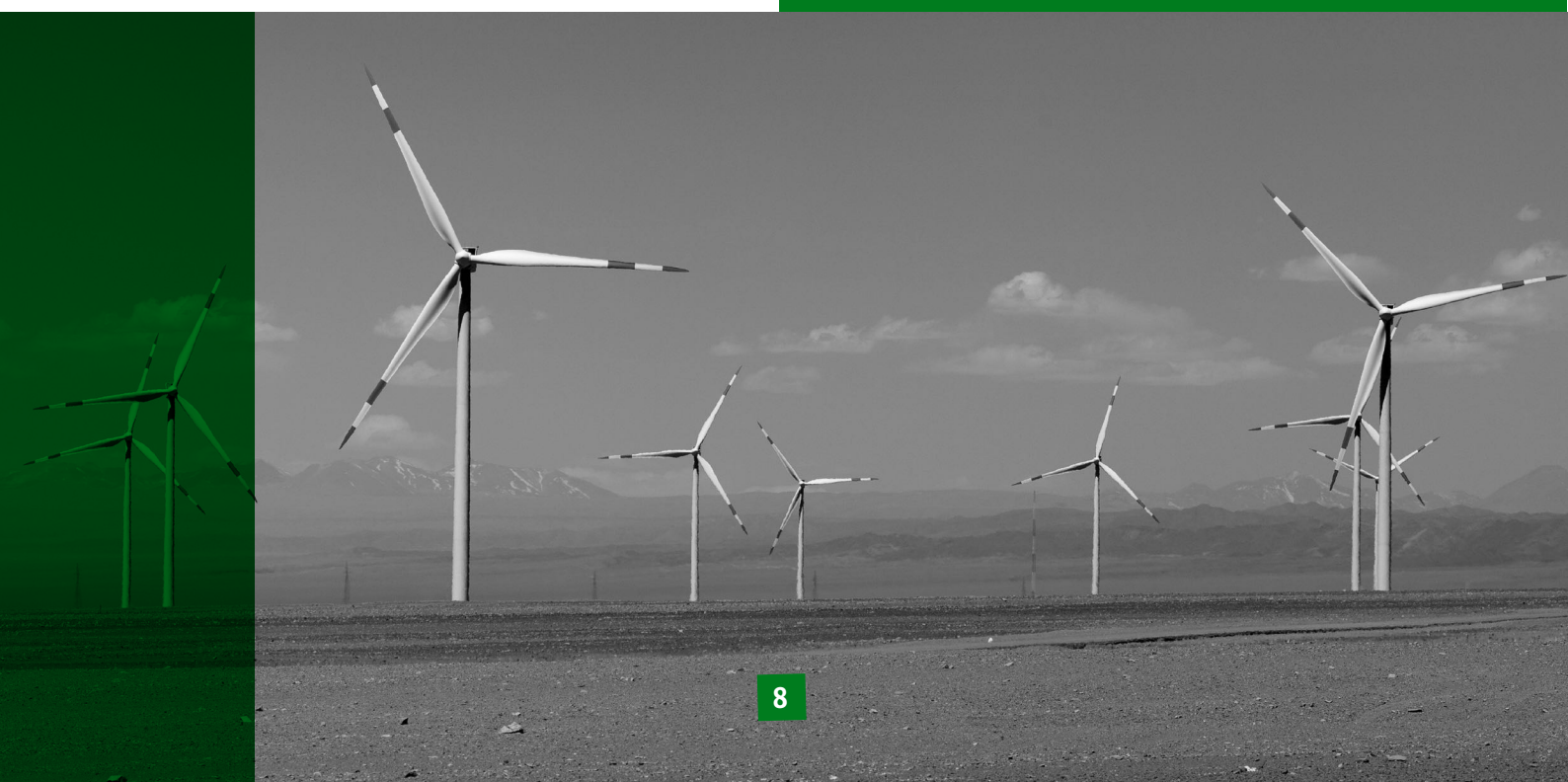
Practical exercises: 2.5 days (20 hours)

Participants will complete both a theoretical and a practical examination.

Target Audience:

- ▶ Wind turbine technicians and maintenance personnel
- ▶ Health and safety officers in the wind industry

Certification: Participants receive the GWO Blade Repair Training (BRT) Certificate.



Control of Hazardous Energies Training (CoHE)

The aim of the course is for the participants to understand and apply safety measures for controlling hazardous energies, including Lockout/tagout (LOTO) procedures, to prevent accidents.

Course Description: This course provides training on energy isolation and Lockout/Tagout (LOTO) procedures to prevent accidents in wind turbines.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

- ▶ Identify hazardous energy sources
- ▶ Implement energy control procedures
- ▶ Perform safe equipment maintenance

Total estimated duration: 3 days

Theoretical instruction: 1.5 days (12 hours)

Practical exercises: 1.5 days (12 hours)

Participants will complete both a theoretical and a practical examination.

Target Audience:

- ▶ Wind turbine technicians and maintenance personnel
- ▶ Health and safety officers in the wind industry

Certification: Participants receive the GWO Control of Hazardous Energies (CoHE) Certificate.

Crane and Hoist Training

The aim is for the course participants to safely operate and handle cranes and hoists in the wind industry, ensuring efficient lifting and movement of heavy components.

Course Description: This course will enable participants, through theoretical and practical training, to ensure safety awareness when using cranes and hoists in service operations and ensure that wind industry personnel can safely operate common types of small, fixed cranes (e.g., eight metric tons/ metre) and fixed hoists in the wind industry onshore and offshore when following manufactures' manuals and relevant documentation and legislation. After having completed this Crane and Hoist Basic User Module, the participants will have the ability to take responsibility as a basic user to safely operate common types of fixed cranes and hoists in Wind Turbine Generator (WTG) environment on basic lifts while following manufacturers' manuals, relevant documentation and legislation.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

- ▶ Identify and understand relevant legislation & lifting equipment-related documentation
- ▶ Develop a Lifting plan and conduct a risk assessment
- ▶ Use Safety Lifting equipment
- ▶ Use lifting accessories
- ▶ Practical: Pre-operation Lifting operation Post lifting

Estimated Duration: 2 days (Participants will complete both a theoretical and practical examination)

Target Audience:

- ▶ Wind turbine technicians and maintenance personnel
- ▶ Health and safety officers in the wind industry

Certification: Upon completing this training course, participants will be awarded a GWO-approved certificate and have the training record uploaded into WINDA. There is no expiry date for this training certificate.

Slinger Signaller Training

The course aims for the participants to effectively communicate and coordinate lifting operations using proper signalling techniques, ensuring safe and precise load handling.

Course Description: This course will enable participants to support and care for themselves and others while working with slinger signalling in the wind industry by possessing the required knowledge, skills, and ability to conduct assigned tasks safely and efficiently. Upon completing GWO's Slinger Signaller Module training course, the participant can work within the wind industry, conducting slinging techniques and signalling during simple lifting operations, meaning lifts conducted based on a lifting plan or covering known hazards.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to understand:

- ▶ Safety & Risk Management
- ▶ Lifting Equipment & Accessories
- ▶ Load Handling & Control
- ▶ Communication & Procedures

Estimated Duration: 2 days (Participants will complete a theoretical and practical examination).

Target Audience

- ▶ Wind turbine technicians and maintenance personnel
- ▶ Health and safety officers in the wind industry

Certification: Participants will be awarded a GWO-approved certificate after successfully completing this training course.

Potential Capacity-Building Initiatives related to Priority 1 Short Courses

The following requirements apply to conducting a corresponding course:

Requirements for conducting the mentioned GWO courses, divided into personnel and material/infrastructural requirements:

Personnel Requirements

Qualified Trainers:

- ▶ Trainers should be certified GWO instructors with extensive experience in the wind energy industry.
- ▶ They should have specific expertise and practical experience in the respective course fields (e.g., working at heights, emergency rescue, first aid).
- ▶ Certifications and ongoing training for trainers must comply with the latest safety and training standards.

Emergency Rescue Experts: For courses like "Advanced Rescue Training," rescue experts with hands-on experience performing rescue operations and applying advanced rescue techniques in turbine environments are necessary.

First Aid Experts: First aid trainers require specialised knowledge in advanced emergency medicine and be skilled in using emergency medical equipment.

Technical Professionals: To provide qualified training to participants in technical courses such as "Basic Technical Training," trainers must possess a solid understanding of mechanics, electricity, and hydraulics.

Specialised Equipment and Machinery Experts: For practical courses like "Blade Repair Training" and "Crane and Hoist Training," experienced technicians and wind turbine maintenance and repair specialists must be available to lead the training sessions.

Training Facilities and Equipment Requirements

Classroom Facilities: Equipped with presentation tools like projectors, whiteboards, and computers for theoretical training.

Practical Training Areas: Suitable training spaces for hands-on exercises, such as a designated area for rescue operations, specialised workshops for mechanical repairs, and a secure environment for working at heights.

Simulation Equipment: Turbine mock-ups, including nacelles, towers, hubs, and simulators for wind turbine operations and emergencies. Specialised Tools and Equipment:

Working at Height and Rescue Equipment: Helmets, safety harnesses, ropes, climbing and rescue devices, elevators, lifeline systems.

First Aid Equipment: AEDs, bandaging materials, oxygen therapy equipment, and emergency medications.

Vehicles and Machines: Necessary machinery for practical exercises, such as cranes, lifting equipment, and special tools for repairing turbine blades.

Safety and Protective Equipment: Barriers, safety markings, fire extinguishers, and medical emergency stations.

Training Materials and Resources

- Provision of course materials, handouts, manuals, and digital resources for participants during and after the course.

Certification and Examination Infrastructure

- Systems for conducting and documenting examinations (theoretical and practical), issuing certificates, and managing course data.
- There is a need for a competent exam centre to ensure proper administration and validation of the examinations.

2.2 Priority 2: Generic Wind Turbine Technician Basic Training Modules

Fundamentals of Electrical Engineering in Wind Turbines

This course aims for participants to gain a comprehensive understanding of electrical systems in wind turbines, enabling them to troubleshoot, maintain, and ensure the safe operation of electrical components within the turbine.

Course Description: This course provides essential training in electrical engineering for wind turbines. Participants will gain a thorough understanding of electrical systems, safety protocols, and troubleshooting techniques. The training includes theoretical knowledge and hands-on exercises using real wind turbine components.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

- Understand the basic principles of electrical engineering in wind turbines
- Identify and troubleshoot electrical faults in wind energy systems
- Read and interpret electrical schematics
- Apply electrical safety procedures and regulatory standards

Total estimated duration: 3 days

Theoretical instruction: 1.5 days (12 hours)

Practical exercises: 1.5 days (12 hours)

Participants will complete both a theoretical and a practical assessment.

Target Audience:

- Wind turbine service technicians and maintenance personnel
- Individuals transitioning into the wind energy sector
- Electrical engineers and technical staff working in wind turbine operations

Certification: Upon successful completion, participants receive a Fundamentals of Electrical Engineering Certificate.



Mechanics and Hydraulics in Wind Turbines

This course aims for participants to develop the skills necessary to maintain and repair mechanical and hydraulic systems in wind turbines, ensuring efficient operation and prompt issue resolution of critical turbine components.

Course Description: This course covers the fundamentals of mechanical and hydraulic systems in wind turbines. Participants will learn about the function, maintenance, and troubleshooting of key components such as gearboxes, rotor bearings, and hydraulic systems. Hands-on training with real turbine components ensures practical experience in fault detection and repair.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

- ▶ Identify and explain key mechanical and hydraulic components of wind turbines
- ▶ Perform maintenance and troubleshooting on mechanical and hydraulic systems
- ▶ Apply best practices for working safely with mechanical and hydraulic equipment
- ▶ Diagnose and resolve mechanical failures in wind turbines

Total estimated duration: 4 days

Theoretical instruction: 2 days (16 hours)

Practical exercises: 2 days (16 hours)

Participants will complete both a theoretical and practical assessment.

Target Audience:

- ▶ Wind turbine service technicians and maintenance personnel
- ▶ Mechanical engineers working in wind turbine operations
- ▶ Individuals interested in gaining expertise in wind turbine mechanics

Certification: Upon successful completion, participants receive a Mechanics and Hydraulics Certificate.

Control Systems and Programming in Wind Turbines

The aim of this course is for participants to acquire the knowledge and expertise needed to program and troubleshoot control systems in wind turbines, ensuring optimal system performance and reliable automation of turbine functions.

Course Description: This advanced course focuses on control systems and programming for wind turbines. Participants will gain hands-on experience with programmable logic controllers (PLCs), control algorithms, and SCADA system integration. The course provides in-depth knowledge of diagnosing and troubleshooting control system faults to optimise wind turbine performance.

Competencies (Learning Objectives): Upon completion of the course, participants will be able to:

- ▶ Understand the structure and function of wind turbine control systems
- ▶ Program and modify PLCs used in wind turbine operations
- ▶ Troubleshoot control system faults and optimise turbine performance
- ▶ Integrate SCADA systems for remote monitoring and diagnostics

Total estimated duration: 5 days

Theoretical instruction: 2 days (16 hours)

Practical exercises: 3 days (24 hours)

Participants will complete both a theoretical and practical assessment.

Target Audience:

- ▶ Wind turbine service technicians specialising in control systems
- ▶ Mechatronics specialists and electrical engineers
- ▶ SCADA system operators and automation professionals

Certification: Upon successful completion, participants receive a Control Systems and Programming Certificate.



Potential Capacity-Building Initiatives related to Priority 2 Short Courses

The following requirements apply to conducting the mentioned courses. These are divided into personnel requirements, methodological and didactic competencies, and material/infrastructural requirements to ensure high-quality, practice-oriented training in wind turbine maintenance and operation.

The following requirements apply to conducting a corresponding course:

Personnel Requirements

Qualified Trainers

- ▶ Trainers must have professional experience in the wind energy sector, particularly in wind turbine maintenance and repair.
- ▶ They should possess formal technical qualifications (e.g., electrical engineering, mechanical engineering, automation technology).
- ▶ Trainers must undergo continuous professional development to stay updated with the latest industry standards and technologies.

Electrical Engineering Experts (for Fundamentals of Electrical Engineering course)

- ▶ Trainers should have certifications in electrical engineering and experience in wind turbine electrical systems.
- ▶ Knowledge of industry standards and safety regulations for electrical work is required.
- ▶ Practical experience with electrical fault detection and troubleshooting in wind turbines is necessary.

Mechanical and Hydraulic Specialists (for Mechanics and Hydraulics course)

- ▶ Trainers must have wind turbine mechanical systems expertise, including gearboxes, rotor bearings, and hydraulic systems.
- ▶ Practical experience in maintenance, assembly, and troubleshooting of mechanical and hydraulic components is essential.
- ▶ An understanding of industry-specific safety protocols and best practices is required.

Control Systems and Automation Experts (for the Control Systems and Programming course)

- ▶ Trainers should have experience in PLC programming and SCADA system integration.
- ▶ Knowledge of wind turbine automation systems and fault diagnostics is required.
- ▶ Experience in software programming for control systems, including Siemens and Beckhoff PLCs, is preferred.

Safety and First Aid Experts

- ▶ Trainers must know safety regulations, risk assessments, and emergency procedures relevant to wind turbine maintenance.

- ▶ A first aid qualification is required to ensure that trainers can respond to emergencies during training.

Methodological and Didactic Competencies

To ensure effective learning, trainers must possess methodological and didactic skills tailored to action-oriented training. These include:

Training Design and Delivery

- ▶ Ability to develop structured, goal-oriented training programs that combine theory with hands-on practice.
- ▶ Competence in creating engaging and interactive learning experiences, ensuring a high level of participant involvement.
- ▶ Application of modern teaching methods, including blended learning approaches, group work, and problem-solving activities.

Action-Oriented Teaching Methods

- ▶ Use of real-world scenarios and case studies to enhance practical learning.
- ▶ Hands-on exercises with real turbine components to simulate real maintenance and troubleshooting tasks.
- ▶ Implementation of learning-by-doing approaches, ensuring that participants actively apply theoretical knowledge in a safe environment.

Assessment and Feedback

- ▶ Competence in evaluating participant performance through practical exercises, written assessments, and oral questioning.
- ▶ Providing constructive feedback to support learners in improving their technical skills.
- ▶ Ability to adapt training to different learning speeds and styles, ensuring that all participants achieve the desired learning outcomes.

Communication and Group Facilitation

- ▶ Strong communication skills to convey complex technical concepts in an understandable and engaging manner.
- ▶ Ability to manage diverse groups of learners, ensuring an inclusive and supportive training environment.
- ▶ Encouraging active participation and problem-solving discussions among participants.

Material and Infrastructural Requirements

Training Facilities and Equipment

- ▶ Classroom Facilities
- ▶ Equipped with presentation tools such as projectors, whiteboards, and computers for theoretical instruction.
- ▶ Seating and workspaces for all participants with access to relevant course materials.

- ▶ Practical Training Areas.
- ▶ Dedicated workshops for hands-on training in electrical engineering, mechanical systems, and control systems.
- ▶ Designated areas with training turbines or turbine components for practical exercises.
- ▶ Simulation Equipment.
- ▶ Wind turbine mock-ups, including nacelles, towers, and control panels.
- ▶ Simulation software for electrical and control system training.
- ▶ Hydraulic test benches for hands-on exercises.

Specialised Tools and Equipment

- ▶ Electrical Training Tools: Multimeters, oscilloscopes, test panels, and safety equipment for electrical work.
- ▶ Mechanical and Hydraulic Equipment: Wrenches, hydraulic test systems, and mechanical assembly tools.
- ▶ Control System Hardware: PLC training kits, industrial controllers, and programming software.

Safety and Protective Equipment

- ▶ Personal protective equipment (PPE), including helmets, gloves, and safety goggles.
- ▶ First aid kits and emergency response equipment.
- ▶ Fire extinguishers and clearly marked emergency exits.

Training Materials and Resources

- ▶ Course handbooks, manuals, and digital resources for participants.
- ▶ Access to industry-relevant documentation and technical reference materials.

Certification and Examination Infrastructure

- ▶ Systems for conducting and documenting both theoretical and practical exams.
- ▶ A structured certification process, including verification of competencies.
- ▶ Secure record-keeping for participant certifications.



3

RECOMMENDATIONS FOR POTENTIAL PARTNERSHIPS

Due to Namibia's lack of training infrastructure, it is recommended that this be developed in the first instance. A good, practical training infrastructure is essential for delivering successful and quality training of Wind Turbine Technicians. Many of the emerging existential training measures require many practical training opportunities. During the surveys in Namibia, it became apparent that various training providers from the key fields are prepared to create such infrastructure for joint utilisation.

GWO has a global network of trainers, and any of their affiliates can be contracted to provide training in Namibia. Training facilities would need to be constructed, or in some instances, temporary mobile facilities can be provided by some of these trainers. Alternatively, permanent facilities can be erected for external trainers to use for the various courses. This option presents several challenges and does not contribute to the long-term success of such training programs within Namibia.

An alternative to utilising external trainers is to develop local capacity. Efforts should be made to engage training providers, organisations, and/or individuals willing to collaborate to implement these trainings. Trainers for each speciality or aspect of the courses need to be identified and trained to become certified GWO trainers for the modules in their respective fields. Facilities need to be equipped with the necessary materials and tools to provide the training by either upgrading existing facilities or constructing new facilities. Finally, candidates eligible for upskilling will need to be identified.

To keep in line with the objectives, it is recommended that the training of GWO courses in Namibia be directly implemented as stated in **Priority 1**. This can be achieved by either bringing in external trainers or to develop local training institutes and trainers within Namibia.

Priority 2 is presented as an alternative to following international standards by developing local courses and although being listed as an option, is not recommended. Priority 1 and Priority 2 are non-complimentary, but rather opposing options.

3.1 Priority 1: GWO Training Modules

Existing Training Providers

Various training providers were interviewed in Namibia, and a few emerged as being willing and able to accommodate the implementation of short courses swiftly. All indicated that assistance and resources would be required to achieve said objectives.

The Namibian Institute of Mining Technology (NIMT) have shown interest in providing industry focused training and are flexible enough to rapidly develop and implement short courses. Their focus on staff development and their ability to remain relevant to the industry indicates that they will

make a good partner for a collaborative venture. Their facilities already meet most of the criteria needed to present the technical courses, but additional equipment and material would be required to provide wind industry-specific courses.

There are several Emergency Management training providers but not many that already include the in depth Working at Heights courses focusing on rescues within the Wind Turbine field. Providers that include Working at Heights should be approached.

Advanced Rescue and specifically Tower Rescues require knowledge and expertise beyond Working at Heights and Basic Rescues. Professionals in the field of Rope Access would be the most suitable to present such courses. Individuals in this field should be approached.

Training of Trainers

Various trainers for each field of speciality (Technical, Safety, Rescue Training) will need to be sent to GWO for a training-of-trainer (ToT) course. The participants will need to pass the courses that they will be teaching as well as the ToT course. Such training will take several weeks or months to complete, depending on the number of modules that need to be completed.

Facilities

Facilities to offer Technical Training, Safety Training and Advanced Rescue are needed and should be equipped with industry specific training material. The facilities can be centralised or across separate locations. NIMT's Arandis campus already meets most of the criteria for the technical training. Additional equipment and materials are required, and their management has indicated a willingness to convert dedicated classrooms if sufficient financial support and a large enough pool of trainees are provided.

Innosun Energy Holding is the owner and operator of the only wind turbines in Namibia and has indicated that they are willing to construct a training centre for Safety Training and Advanced Rescue Training in Lüderitz dependent on substantial financial support.

Candidates

Lastly, it is necessary to mention the potential trainee candidates. In line with the focus to upskill existing qualified artisans, several occupations have been identified as most suitable.

- ▶ Electrical General Engineering
- ▶ Millwright/Mechatronics
- ▶ Instrumentation and Control

All of these occupations have a foundation in Electrical Engineering, which is important because of the high risk of electrical shock injuries when working as a Wind Turbine Technician. Candidates will need to demonstrate an aptitude in electrical, mechanical, electronic knowledge along with accompanying skills and prioritise safety. Working at heights is a requirement and the fear of heights can be a disqualifying factor for any candidate. A more extensive list of requirements can be developed.

3.2 Priority 2: Generic Wind Turbine Technician Basic Training Modules

For this report and the stated objectives, the development of local content and courses from first principles is not recommended. The Wind industry in Namibia is undeveloped and suffers from a severe lack of experts in the field. To develop such courses, the local experts would need to be involved, standards created, courses fully developed, trainers trained, and facilities built. International partnerships are therefore recommended. Courses may be developed locally or adopted from institutions abroad.

Training of Trainers

Various trainers for each field of speciality (Technical, Safety, Rescue Training) will need to be sent abroad to gain the required knowledge and undergo a training-of-trainer course. The participants will need to fully master their field and develop the courses that they will be teaching and be effective in their teaching methods. Such training will take several months to complete, depending on the number of modules that need to be completed.

Facilities

Facilities to provide Technical Training, Safety Training and Advanced Rescue are required and should be equipped with industry-specific training material. The facilities can be centralised or across separate locations.

NIMT's Arandis campus already meets most of the criteria for the technical training. Additional equipment and materials are needed, and their management has indicated a willingness to convert dedicated classrooms if sufficient financial support and a large enough pool of trainees are provided.

Innosun Energy Holding is the owner and operator of the only Wind Turbines in Namibia and has indicated that they are willing to construct a training centre for Safety Training and Advanced Rescue Training in Lüderitz dependent on substantial financial support.

Potential Trainee Candidates

With the focus on longer short courses, it would be possible to provide training to a wider audience. In line with the focus to upskill existing qualified artisans, several occupations have been identified as most suitable.

- ▶ Electrical General Engineering
- ▶ Millwright/Mechatronics
- ▶ Instrumentation
- ▶ Fitting and Turning
- ▶ Diesel Mechatronics

All of these occupations have a foundation in Electrical Engineering, which is important because of the high risk of electrical shock injuries when working as a Wind Turbine Technician. Candidates will need to demonstrate an aptitude in electrical, mechanical, and electronic knowledge, along with accompanying skills and prioritise safety. Working at heights is a requirement, and the fear of heights can be a disqualifying factor for any candidate.

Recommendations for International Cooperation

A collaboration with Deutsche Windtechnik to promote the training of wind turbine technicians in Namibia provides access to high-quality training programs as well as benefiting the personnel and infrastructural strengths of the company. Deutsche Windtechnik owns impressive expertise and experience in wind turbine maintenance and technology, gained over years of industry practice. The company's trainers are both certified professionals and experienced practitioners with extensive knowledge in fault diagnosis, maintenance, and repair of wind turbines. Their ability to clearly convey complex technical content, combined with practical experience, ensures that participants develop the necessary skills to succeed in the dynamic wind energy industry.

In terms of infrastructure, Deutsche Windtechnik is well-equipped to deliver hands-on training. Their training facilities are fitted with state-of-the-art technology, including simulation equipment and real turbine components, giving participants the opportunity to develop their skills in a realistic environment. This setup ensures that the training is both theoretical and practically implementable, which is essential for the maintenance and operation of wind turbines.

The combination of well-qualified trainers and existing infrastructure ensures that a collaboration with Deutsche Windtechnik in Namibia will lead to sustainable and effective training of wind turbine technicians. By training local trainers as multipliers, the harnessed knowledge can then effectively be disseminated and subsequently preserved in the long term, laying the foundation for building a highly skilled pool of technicians in Namibia while successfully implementing wind energy projects in the region.



4

CONCLUSION

The analysis confirms that Namibia currently lacks dedicated training programmes for Wind Turbine Technicians, despite the central role of wind energy in the country's renewable energy and green hydrogen ambitions. Existing technical courses provide a partial foundation, but they do not address the specialised requirements of wind turbine installation, commissioning, maintenance, and safety.

This gap increases risks related to workplace safety, efficiency, and compliance with international standards.

International benchmarking highlights the importance of Global Wind Organisation (GWO) modules and other industry-recognised certifications, which remain absent in Namibia.

To align with global best practice, Namibia must prioritise the introduction of GWO-accredited short courses, complemented by training-of-trainers initiatives and investment in practice-oriented facilities and equipment.

Partnerships with institutions such as NIMT and international providers will be critical to build local capacity and ensure long-term sustainability.

In conclusion, developing a structured pathway for Wind Turbine Technicians — anchored in international certification, practical safety training, and industry collaboration — is essential for Namibia to secure a competent workforce and to advance its renewable energy and green hydrogen sectors.

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