T-shore Education

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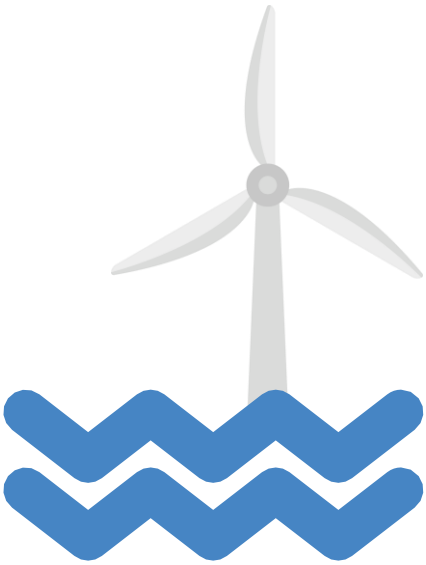
Module and Scenario Overview



Module:
Offshore Renewable Energy
Learning scenario:
Introduction to offshore renewable energy

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1 Description of module

In this module, training participants will explore the innovative field of offshore renewable energy, focusing on wind turbines installed in marine environments. The module will cover a broad range of topics, ranging from the different types of wind turbines through to basic maintenance routines and the life cycle of a modern wind turbine.

The module has been created by two technical schools in the north of the Netherlands, in collaboration with our T-Shore partners in order to give training participants a complete understanding of the tasks and competencies needed to become a basic level wind technician. Furthermore, this module aims to enthuse and inspire training participants to consider the growing possibilities of renewable energy.

1.1 Theory

The module consists of a theoretical part, “The introduction to Wind Energy", for aspiring wind technicians. It covers a comprehensive set of topics, providing training participants with the knowledge and skills necessary to work in the wind energy sector. Throughout the course, training participants will explore the following key areas:

1. History of Wind Energy: Training participants will study the evolution of wind energy from early windmills to modern wind turbines, analysing important milestones, innovations, and the role of wind energy in the global energy transition.
2. What is Wind? The focus will be on the fundamental physics of wind, including how wind is formed, its patterns, and its impact on turbine efficiency and power generation.
3. Three Types of Wind Turbine: Training participants will differentiate between horizontal axis, vertical axis, and hybrid wind turbines, examining their components, advantages, and design considerations.
4. Onshore or Offshore Wind Turbines? The comparison between onshore and offshore turbines will be covered, including the factors that influence site selection and installation, such as wind speeds, environmental conditions, and logistical challenges.
5. Operating Principles: Training participants will gain an understanding of how wind turbines capture wind energy and convert it into mechanical energy, focusing on rotor speed and power output.
6. Generation of Power: The conversion of mechanical energy into electrical power will be studied, including the role of generators, electrical components, and the challenges of matching power generation with grid demand.
7. Control of Wind Turbines: Training participants will learn about control systems that optimise turbine performance, including yaw and pitch control systems, and how sensors and actuators adjust turbine operations for efficiency and safety.
8. Wind Turbine Mechanical System: Training participants will explore the mechanical components of wind turbines, focusing on the rotor, gearbox, and drive train, along with common failures and maintenance practices.
9. Repair and Maintenance: The course will provide practical knowledge in maintaining wind turbines, covering mechanical, electrical, and hydraulic systems and troubleshooting techniques.

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10. Inspection and Fault-finding: Training participants will develop skills in inspection and fault-finding, using diagnostic tools to detect issues early and prioritise corrective actions.
11. Safety and Other Issues: Emphasis will be placed on safety protocols, including fall protection, electrical safety, and industry regulations for working at height and in confined spaces.
12. End of Life (Lifecycle): The lifecycle of wind turbines, including decommissioning and recycling, will be studied, with a focus on environmental and economic considerations.
13. Power to X: Training participants will explore the integration of wind energy with emerging technologies like hydrogen production and carbon-neutral fuels, contributing to decarbonisation efforts.
14. Becoming a Wind Technician: The course will culminate in preparing training participants for a career in wind energy, covering the necessary technical, practical, and safety competencies required to become a qualified wind technician.

1.2 Practical

No practical part is included in this module in addition to the e-Learning module theoretical

1.3 Evaluation

Throughout the entire module, the participant is evaluated by the teacher and the instructor. The final evaluation is based on the work processes and core tasks described in the Learning scenario framework.

2 Instructor pre-qualification

To conduct the learning module theory and practical training, instructors must meet the minimum requirements below:

Knowledge: specialised training or engineering knowledge in mechanical or electrical engineering, not eqf 4 but 3 that should be the level. *Trainers must have specialised technical training, e.g. as an electrician, automation technician or equivalent, with proven experience in mechanical or electrical engineering – equivalent to* ***EQF level 5****.*

Skills: Fundamentals of Wind Energy: Understanding the core concepts of wind energy, such as the physics of wind, how wind turbines work, and the basic principles of energy conversion.

Turbine Technology: Familiarity with different types of wind turbines (horizontal-axis, vertical-axis), materials used, and mechanical/electrical systems involved.

Aerodynamics: Knowledge of how wind interacts with turbine blades and how to optimise the design for maximum efficiency. Energy Storage and Grid Integration: Understanding how wind energy integrates into the power grid, storage systems, and the challenges of variability in wind power.

Environmental Impact: Basic knowledge of the environmental benefits and challenges of wind energy, including land use, wildlife impact, and noise considerations.

Real-World Case Studies: Ability to incorporate case studies from operational wind farms, technological advancements, and successful projects to provide context.

Ability: Simplification of Complex Topics: Ability to break down complicated concepts into manageable, understandable portions for training participants who may not have deep technical backgrounds.

Hands-On Learning: Designing and implementing practical demonstrations, such as small wind turbine models, simulations, or lab experiments, to reinforce theoretical knowledge.

Assessment Techniques: Developing assignments, quizzes, and exams that assess both theoretical understanding and practical skills.

Interactive Teaching: Engaging training participants in discussions, group projects, and interactive learning experiences, fostering critical thinking and problem-solving.

Communication Skills:

Clear and Concise Communication: Ability to explain technical concepts in simple language and engage training participants with varying levels of background knowledge.

Visual Aids: Using diagrams, charts, animations, and videos to explain concepts, particularly when dealing with complex technical details like airflow dynamics or turbine performance.

3 Participant pre-qualification

To conduct the module (Theory and practical training), participants must meet the minimum requirements below:

Knowledge: Basic knowledge of wind turbine construction, rotating machinery
Skills: use of manual mechanical tools
Ability: safe work evaluation of situation
Communication skills: use different aids to communicate

4 Overview of theoretical and practical content, scenario documents, training equipment and infrastructure

Name	Q/A	Type	Category	Where to use
Laptops with	4	Real-life online equipment	Theoretical part equipment	Theoretical part
Design and simulation software	50	Digital material	Theoretical part material	Theoretical part
Digital learning material	Per training participant	Digital material	Theoretical part material	Theoretical part

Inspection report	Per training participant	Digital	Theoretical part material	Preparation for practical exercises part
Safety equipment for practical training exercises	Per training participant	Real-life Digital material	Training infrastructure	Preparation for practical exercises part
Mechanical tools set (manual torque wrench, hydraulic torque tensioners screwdriver etc.)	Per training participant	Real-life Digital equipment	Tools	Preparation for practical exercises part
Monitoring station	1	Real-life equipment	Digital equipment	Preparation for practical exercises part

Note The list is provided for a group of 12 training participants. Training participants are not necessarily busy with the same tasks at the same time.

5 Timeframe

This E-Learning module takes about 10 to 12 hours to complete.

6 Learning methods

Part	Learning method
Theory part	E-learning on Moodle T-Shore, Rise 360, Wikiwijs presentations

Note Learning methods depends on accessibility of infrastructure and equipment and in company trainings and excursions.

7 Main learning outcomes for the module

Category	Learning Outcomes and Competencies	Chapters
Safety and Risk Management	- Understand and apply workplace safety protocols, including fall protection and confined space entry.	Safety and Other Issues (Chapter 11): Fall protection, emergency procedures, electrical safety, hazard identification.
	- Familiarity with PPE usage.	
	- Ability to conduct risk assessments and respond to emergency situations.	

Basic Wind Turbine Operations	- Knowledge of wind turbine components (rotor, nacelle, tower, inverters, converters, brake systems, electric yaw motors, switching systems, alternator converters, switchgears and transformers).	What is Wind? (Chapter 2): Wind formation, pressure differences, Coriolis effect.
	- Understanding of wind turbine operating principles and electrical systems.	Operating Principles (Chapter 5): Wind speed, rotor speed, energy conversion.
	- Ability to monitor and assess the turbine's performance.	Generation of Power (Chapter 6): Mechanics of electrical generation.
Electrical Systems	- Familiarity with electrical circuits, cables, and controls and regulation systems in wind turbines.	Generation of Power (Chapter 6): Electrical generation, grid systems.
	- Understanding of power generation, transmission, and distribution.	Control of Wind Turbines (Chapter 7): Control systems, yaw/pitch, optimisation.
	- Ability to troubleshoot basic electrical systems and fault detection.	
Mechanical Systems	- Ability to inspect, maintain, and repair mechanical systems such as gearboxes and generators.	Wind Turbine Mechanical System (Chapter 8): Rotor, gearbox, drivetrain.
	- Knowledge of lubrication, cooling systems, and mechanical troubleshooting.	Repair and Maintenance (Mechanical, Electrical, Hydraulic) (Chapter 9): Troubleshooting, repairs.
Hydraulics	- Understanding hydraulic systems in wind turbines.	Repair and Maintenance (Mechanical, Electrical, Hydraulic) (Chapter 9): Hydraulic troubleshooting.
	- Ability to troubleshoot and repair hydraulic systems (e.g., pitch systems).	
Installation and Maintenance	- Basic understanding of installation procedures for wind turbine components.	Installation and Maintenance (Chapter 12): Installation, site setup, commissioning, maintenance.
	- Ability to assist in site setup and commissioning.	Inspection and Fault-finding (Chapter 10): Inspection techniques, fault-finding.
	- Conducting routine maintenance (e.g., lubrication, adjustments, component inspection).	
Troubleshooting and Diagnostics	- Skill in identifying faults and performing diagnostics on wind turbine systems.	Repair and Maintenance (Mechanical, Electrical, Hydraulic) (Chapter 9): Troubleshooting methods.
	- Ability to use diagnostic tools and interpret data to identify and resolve issues.	Inspection and Fault-finding (Chapter 10): Diagnostic tools, fault identification.
Environmental Awareness	- Understanding of environmental regulations and the impact of wind energy production.	Power to X (Chapter 13): Wind power, hydrogen production, decarbonisation.

	- Ability to assess and mitigate environmental risks on wind farms.	End of Life (Lifecycle) (Chapter 12): Decommissioning, recycling, environmental impact.

7.1.1 Chapters Overview (Integrated into the Module)

Chapter	Core Task	Work Process
History of Wind Energy (Chapter 1)	Understand the historical context of wind energy.	Study key milestones, innovations, and the role of wind in the energy transition.
What is Wind? (Chapter 2)	Grasp wind formation and physics.	Learn atmospheric pressure differences, Coriolis effect, and seasonal variations.
Three Types of Wind Turbines (Chapter 3)	Differentiate between horizontal, vertical, and hybrid wind turbines.	Explore components, advantages, limitations, and site considerations.
Onshore vs Offshore Wind Turbines (Chapter 4)	Compare onshore and offshore wind turbines.	Study environmental conditions, logistics, and maintenance challenges.
Operating Principles (Chapter 5)	Understand how wind turbines capture and convert wind energy.	Study the relationship between wind speed, rotor speed, and power output.
Generation of Power (Chapter 6)	Learn how wind energy becomes electrical power.	Explore electrical generation mechanics and challenges in grid matching.
Control of Wind Turbines (Chapter 7)	Study control systems for optimising turbine performance.	Learn about sensors, actuators, and pitch/yaw controls.
Wind Turbine Mechanical System (Chapter 8)	Examine turbine mechanical components.	Study the rotor, gearbox, drivetrain, and common failures.
Repair and Maintenance (Mechanical, Electrical, Hydraulic) (Chapter 9)	Learn to maintain and repair turbines.	Troubleshoot and repair mechanical, electrical, and hydraulic systems.
Inspection and Faultfinding (Chapter 10)	Master inspection and faultfinding techniques.	Use diagnostic tools, identify issues, prioritise corrective actions.
Safety and Other Issues (Chapter 11)	Learn safety protocols and risk management.	Understand fall protection, electrical safety, and hazard identification.
End of Life (Lifecycle) (Chapter 12)	Understand the lifecycle of wind turbines.	Analyse decommissioning, recycling, and environmental impacts.
Power to X (Chapter 13)	Explore wind energy integration with hydrogen and methanation technologies.	Study green hydrogen production, and the

		decarbonisation potential of wind energy.
Becoming a Wind Technician (Chapter 14)	Gain skills and qualifications for a wind technician career.	Participate in hands-on training, gain certifications, and explore career pathways.

8 Theory part

8.1 Learning theory

This content will be delivered primarily in a classroom setting, where participants can engage in live discussions, ask questions, and receive immediate feedback. Additionally, e-learning modules will be made available to training participant s to complete prior to the practical training sessions. These online modules will allow training participant s to learn at their own pace and revisit concepts as needed. The learning approach will be a hybrid of both in-person and online methods, ensuring that training participant s are exposed to different learning styles and have access to various resources for building knowledge

Note: Some sections of the module, especially those involving hands-on practise, will require training participant s to combine their theoretical knowledge with practical application. training participant s will need to transition between theory and practise, engaging in both classroom learning and fieldwork to solidify their understanding.

Instructor's Responsibilities:

- Present Introduction/Opening: The instructor should begin with an engaging and informative presentation introducing the core concepts of wind energy. This should include:
- A brief history of wind energy, including early windmills and the evolution to modern wind turbines.
- The key components of a wind turbine, such as the rotor, nacelle, tower, and generator.
- The basic principles of wind energy conversion, including the physics behind wind speed, rotor speed, and energy production.
- The various types of wind turbines (horizontal axis, vertical axis, and hybrid designs) and their uses.
- A discussion of the environmental and economic benefits of wind energy, as well as its role in the global energy transition.
- An overview of safety protocols, risk management, and the importance of personal protective equipment (PPE) in the field.
- The instructor should also clarify expectations for the course, outline key learning outcomes, and explain how theoretical knowledge will be applied in the practical components of the training.

- Feedback Questionnaire: The instructor should clearly inform training participant s about the importance of providing feedback on the course. This includes emphasising the value of completing the feedback questionnaire at the end of the theory section to:
- Provide insights into the effectiveness of the course content and delivery methods.
- Help improve future training sessions.
- Ensure that any areas of confusion or difficulty are addressed in future iterations of the course.
- Theory Material Delivery: The instructor should present the theoretical content in a structured and engaging manner. This may include:
- Clear explanations of technical concepts such as wind turbine components, electrical and mechanical systems, and hydraulic systems used in wind turbines.
- Examples and case studies demonstrate the practical application of these concepts in the real world.
- Interactive discussions or activities to reinforce understanding and encourage critical thinking.
- The instructor should also confirm that training participant s have completed any required e-learning modules prior to the practical sessions. These e-learning modules should cover foundational topics such as the history of wind energy, basic wind turbine operations, and environmental awareness. The online learning tools will allow training participant s to learn at their own pace and help them come prepared for the hands-on portions of the training.
- Collect Feedback: After the theoretical portion of the training, the instructor should collect feedback from participants. This feedback should be used to:
- Assess how well the training participant s have understood the material.
- Identify any gaps in knowledge or areas that require further explanation.
- Gather suggestions on how to improve future sessions or modules.
- The feedback process is a key part of maintaining the quality and effectiveness of the training program.

Participant's Responsibilities:

- Learn the Theory: Participants must engage fully with the theoretical component of the module. This includes:
- Actively participating in classroom discussions and activities.
- Completing e-learning modules before attending practical sessions, to ensure that training participant s have the necessary background knowledge in areas such as turbine components, electrical systems, and wind energy generation.
- Taking notes, reviewing material, and using additional resources as necessary to deepen their understanding.
- Preparing for hands-on training by grasping the theoretical concepts behind turbine operation, mechanical and electrical systems, and safety protocols.

- It is essential that training participants build a strong basic theoretical foundation in order to succeed during the practical segments, where they will apply the concepts, they have learned.

- Ask Questions: It is encouraged that participants ask questions throughout the course to ensure clarity and deeper understanding. This includes:
- Asking for clarification on concepts related to wind turbine design, electrical systems, hydraulics, and environmental considerations.
- Seeking practical advice on how to apply theoretical knowledge to real-world situations, particularly in troubleshooting and maintenance tasks.
- Participating in interactive discussions and sharing their thoughts on the material to foster collaborative learning.
- By engaging in open communication with the instructor and peers, participants can deepen their understanding and address any uncertainties they may have.
- Complete Feedback Questionnaire: At the end of the theoretical portion, participants should complete the feedback questionnaire. This is an opportunity for them to:
- Reflect on their learning experience and how well the material was delivered.
- Provide suggestions for improving the training sessions, including content, teaching methods, and resources.
- Share any challenges they faced or topics they feel need further clarification.
- The feedback questionnaire is critical for the continuous improvement of the training program and ensuring it meets the needs of all training participants.

The curriculum delves into the mechanical components of turbines, including the rotor, gearbox, and drive train, along with maintenance practices to ensure reliability. Training participants gain practical skills in repair, maintenance, inspection, and fault finding, with a strong emphasis on safety protocols and risk management.

It also addresses the lifecycle of wind turbines, from construction to decommissioning and recycling, considering economic and environmental impacts. The integration of wind energy with emerging technologies like hydrogen production and methanation is explored, highlighting its potential for decarbonisation.

Finally, the programme prepares training participants for a career in wind energy by developing technical and safety competencies, hands-on training, and understanding industry certifications and career pathways. This holistic approach equips learners with both theoretical knowledge and practical skills needed in the wind energy sector.

Detailed learning outcome	Main learning outcome
Understand the evolution of wind energy from early windmills to modern turbines.	Study historical milestones, innovations, pioneers, and wind energy's role in today's energy transition
Learn how wind is formed and its patterns.	Examine atmospheric pressure differences, the Coriolis effect, and how wind speeds influence turbine efficiency.
Differentiate between horizontal axis, vertical axis, and hybrid wind turbines.	Compare components, advantages, limitations, and site-specific design considerations.
Compare onshore and offshore turbines	Analyse environmental conditions, installation challenges, maintenance, and cost implications
Understand how wind turbines convert wind energy into mechanical energy.	Learn about rotor dynamics, blade angles, and energy efficiency
Explore how mechanical energy is converted into electricity.	Study generators, converter systems, and grid integration challenges.
Learn about control systems for optimising turbine performance.	Examine yaw control, pitch control, and sensor systems.
Understand the mechanical components like rotor, gearbox, and drive train.	Study energy transfer, maintenance practices, and design factors for reliability.
Master maintenance and repair of mechanical, electrical, and hydraulic systems.	Develop troubleshooting skills and preventive maintenance schedules.
Learn inspection techniques and fault detection.	Utilise diagnostic tools and prioritise corrective actions.
Understand safety protocols and risk management.	Study emergency procedures, hazard identification, and industry regulations.
Learn about the lifecycle from construction to decommissioning and recycling.	Analyse economic, environmental, and technical considerations.
Explore integrating wind energy with hydrogen production and methanation.	Study green hydrogen, carbon-neutral fuels, and decarbonisation
Acquire skills and qualifications for a career as a wind technician.	Participate in hands-on training, gain certifications, and explore career opportunities.

8.2 Risk assessment

This module consists solely of a theoretical e-learning module, and therefore there isn't a risk assessment.

9 Practical part - introduction

This module consists solely of a theoretical e-learning module, and therefore there isn't a practical part.

10 Preparation for practical exercise

This module consists solely of a theoretical e-learning module, and therefore there isn't a practical exercise.

11 Practical skill training

This module consists solely of a theoretical e-learning module, and therefore there isn't a practical skill training.

12 Learning scenario

This module consists solely of a theoretical e-learning module, and therefore there isn't a learning scenario for practical training.

13 Completion of training practical part

This module consists solely of a theoretical e-learning module, and therefore there isn't a completion of practical part.

14 Learning module & scenario evaluation

Module part	Exercise name	Evaluation method
Theory	learning theory	LMS system Moodle verification that participant completed e-learning

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