

# SDG14 Future of the Ocean

## MM3: Offshore Renewable Energy



### Micro-Module 3: Offshore Renewable Energy

#### Research and Development

#### Lesson 9: Learners Test Wind Turbine Foundations

**Subjects: Climate Action and Sustainable Development, Design, English, Engineering Science**

#### **Lesson Title and Summary: Learners Test Wind Turbine Foundations**

In this lesson, learners will test the foundations they built in the previous lesson in a simulated sea environment using a large plastic crate filled with water and sand. Working in small groups, the learners are challenged to think critically about stability, the weight of the turbine, the depth in the sand that their foundation will be buried, and the ability to withstand waves and strong winds. This hands-on testing phase allows the learners to observe the performance of their designs and consider what changes they might consider for better performance.

#### **Vocabulary: Test, Prototype, Offshore Wind Turbine, Stability, Foundation**

#### **In this lesson, the learner will:**

- Test a prototype in a simulated environment
- Iterating a design based on testing
- Environmental awareness and responsibility
- Basic engineering concepts, adaptability and refinement
- Critical thinking and problem-solving

#### **Materials**

- Teachers notes
- Large plastic crate that can be filled with water to test the turbine foundations (plus towels for any spills)
- Sand that can be put at the bottom of the crate to simulate the seabed
- Wooden spoon or spade/ paddle/ oar or something that can be used to mix/stir the water to generate movement
- Hair-dryer to simulate the wind

**7** AFFORDABLE AND CLEAN ENERGY



**9** INDUSTRY, INNOVATION AND INFRASTRUCTURE



**11** SUSTAINABLE CITIES AND COMMUNITIES



**13** CLIMATE ACTION



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## L9 Learners Test Wind Turbine Foundations



### ACTIVITY INSTRUCTIONS

#### Activity 1: Testing – round 1 (20 mins)

1. Invite the groups to test their turbine foundations in the large plastic crate filled with water and sand. See teacher's notes.
2. Learners will need to take time to get their turbine to float/ balance on the water, and/ or embed the foundation into the sand at the bottom.
3. Generate movement in the water using the paddle/ oar/ spade/ wooden spoon.
4. Use the hair dryer to simulate the wind.
5. Encourage them to observe the performance of their designs and make notes of any adjustments needed.

#### Activity 2: Group Discussion (10 mins)

1. Gather the learners for a group discussion after all groups have tested their foundations.
2. Ask each group to share their findings, what they learned, and any modifications they would make.
3. Depending on the time available this can be done group by group or a selection from the class

#### Activity 3: Testing - round 2 (20 mins)

1. Invite learners to test their modified designs to see if they worked any better.
2. Encourage learners to observe the performance of their designs and make notes of any adjustments needed.
3. Depending on the time available, learners can share their findings. This can be done group by group or a selection from the class

### REFLECTIVE EXERCISE: 3-2-1

- Three things they feel they have learnt from the exercise
- Two things they found most interesting and would like to explore more
- One – their opinion they have about the site / exercises

Use Post-its or a Mentimeter survey - [mentimeter.com](https://www.mentimeter.com) to gather reflections

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### EXTENSION / REDUCTION ACTIVITIES:

**Reduction:** For a shorter class, limit the testing time to a shorter period (e.g., 5 minutes per group) to streamline the activity while still allowing for meaningful testing and discussions. Instead of having each group present their design choices, facilitate a brief group discussion where learners share one thing they learned from testing their turbines and foundations.

**Extension:** For a longer class, introduce additional variables for testing, such as varying the depth of water, the depth of sand, the amount of movement in the water - to explore how these factors impact the stability and performance of the turbine and foundation. Have groups record their observations and create charts or graphs to compare the performance of different foundation designs.

### MEDIA BOX: (materials, online video links, extra resources, case studies etc)

The Foundation of Wind Turbines - IN 60 SECONDS – DOB Academy [1:22 mins]

[https://www.youtube.com/watch?v=NQwuRV2MFs8&ab\\_channel=DOB-Academy](https://www.youtube.com/watch?v=NQwuRV2MFs8&ab_channel=DOB-Academy)

Watch the World's First Floating Wind Farm Ride the Waves | National Geographic [2:23 mins]

[https://www.youtube.com/watch?v=sgCA5e7K7r8&ab\\_channel=NationalGeographic](https://www.youtube.com/watch?v=sgCA5e7K7r8&ab_channel=NationalGeographic)

Wind Energy Ireland wants more renewable energy targets [1:51 mins]

[https://www.youtube.com/watch?v=52AR4W1vc10&ab\\_channel=RT%C3%89News](https://www.youtube.com/watch?v=52AR4W1vc10&ab_channel=RT%C3%89News)

Report (22 pages): Erosion of foundations of Arklow Bank Wind Farm:

[https://eprints.hrwallingford.com/595/1/HRPP320\\_Seabed\\_scour\\_assessment\\_for\\_offshore\\_windfarm.pdf](https://eprints.hrwallingford.com/595/1/HRPP320_Seabed_scour_assessment_for_offshore_windfarm.pdf)

### Local Trip / Expertise / Additional Work and Assessments

Invite a Civil Engineer to come give a talk (or a video call) on the construction challenges of offshore wind turbines. Prepare some interview questions for them. For example, how long does it take to build an offshore wind farm? How much does it cost? How many people are needed to construct them?

**Assessment Suggestion:** Use Media Communication 2 - Research Poster for learners to share their findings within a public context, this could be as an exhibition at the school or local library or community centre

## MM3: L9 TG TESTING THE FOUNDATIONS



If possible, it's best to use a plastic crate that is relatively shallow, but that is wide and long. Fill the plastic crate with water. Carefully add sand to the bottom of the crate so that it stays settled on the bottom and doesn't become suspended in the liquid. Using sand that has larger grain sizes, rather than soft powdery sand will help with this. You want to aim for at least 8-10 inches of sand, so depending on the size of the crate, this could require a couple of bags of sand.

We will be asking students to place their wind turbine into the water. Some students might have designed a turbine where the foundation is a long column that sticks directly into the sand. Others might have designed a turbine that is supposed to float on the water, with an anchor embedded in the sand. They will probably have used the image in the worksheet as inspiration.

We are generally never worried about the effect of the force of the wind on the turbine itself. We are more worried about the force of the sea causing erosion of our foundations on the seabed. If our wind turbine foundations became exposed, in theory our turbine could just float away, or flop over, or sink.

To 'simulate' the force of the waves acting on the seabed, use a large wooden, or perhaps a paddle/ oar. Ideally this will disturb the sand and cause erosion-type effects on the foundations of the students' turbines.