In collaboration with:

TEACHERS' TOOLKIT

Learning wind energy in **primary schools**

MODULE 4

LEARNING ABOUT WIND

OVERVIEW

By conducting simple experiments, students can understand how wind is formed and what makes the blades of a wind turbine spin. They can learn about different types of wind through global wind maps. A research assignment will allow students to learn about the history of wind, from sailing ships to modern wind turbines. We use our respiratory function to play wind instruments, so how does our respiratory system work?

GRADES

5-6th Primary (10-12 yo)

TIME

- Three (50-minute) classes for wind and experiments
- Three (50-minute) classes looking at the global wind map and wind types
- Three (50-minute) classes looking at the history of wind

SUBJECTS

- Science/Technology
- Physics
- Geography
- History

LEARNING OBJECTIVES

At the end of this module, students will have acquired the following knowledge and competences:

Knowledge

- What is wind? How is it created?
- Aerodynamics: general principles
- Wind types around the world
- Historical periods: ways of life and beliefs of different civilisations
- The respiratory system: overall functioning + diagram

Competences

- Work on the scientific method
- Formulate a hypothesis and verify it
- Study a map of the world and find relevant clues relevant to the theme
- Classify these clues in groups
- Memorise information and be able to rewrite it in their own words in a synthesised way
- Research historical documents and find relevant information
- Observe a dissection and make an observational drawing
- Write an account of the dissection

LESSON PLAN

MATERIALS

- Glass filled with water
- Card
- Balloon
- Plastic bottle
- Hot water
- Cold water (ice)

METHOD

STEP 1
Assessing student knowledge about wind

Students start by answering the question:

What do I know about wind?

- Each student puts his/her thoughts about wind (as representations) down in a drawing and a text. An example of the text: ''There is more wind at sea than on land''
- Each student explains their drawing and text to the rest of the class
- This will serve as a starting point for the upcoming activities, when discussing wind

STEP 2
Putting together wind and aerodynamics experiments

PART I WIND

Based on the students' ideas, the next two experiments will try to build on their knowledge of wind. The experiments are carried out according to the scientific approach.

EXPERIMENT 1

Air pressure, also called atmospheric pressure

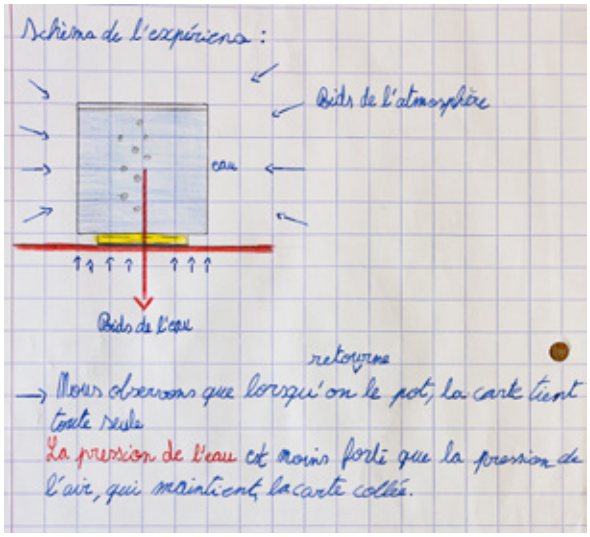
A glass is filled to the brim with water and covered with a card. The glass is slowly turned upside-down. What will happen?

Hypothesis:
Students make their own hypotheses:
- Small air bubbles will rise to the surface
- The paper will get absorbed and won't hold in place
- The paper will hold

Observation:
Students observe that when the glass of water is turned upside-down, the card sticks to the cup on its own and doesn't fall.

Interpretation:
The teacher explains that the pressure of the water is weaker than the pressure of the air. It is the pressure of the air, also called atmospheric pressure, that keeps the card sticking to the glass.

FIG. 28
Student notebook. Experiment 1 on air pressure.



EXPERIMENT 2

The effects of temperature differences

- Remove the cap from a bottle and pass the neck of a balloon around the neck of the bottle
- Place the bottle with the balloon in a bowl of boiling water, then in a bowl of cold water

What will happen?

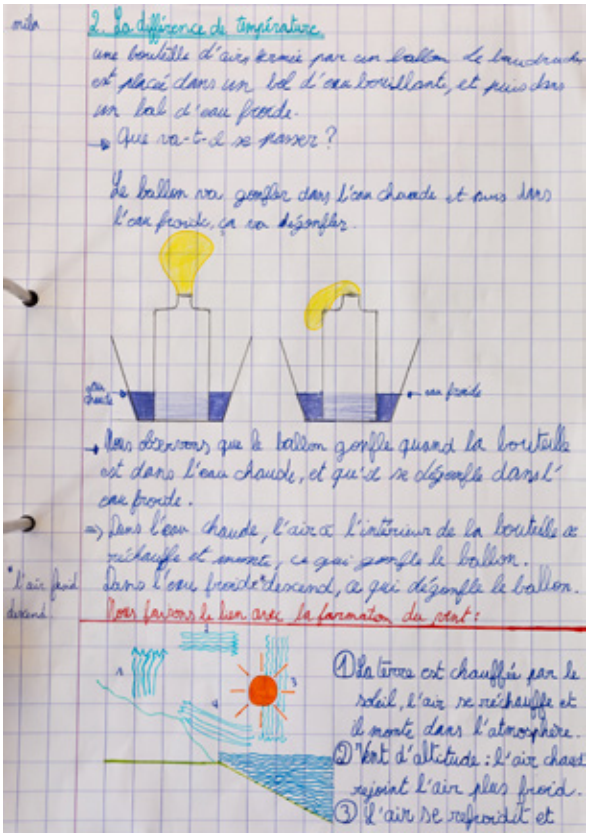
Observation:

The balloon inflates when the bottle is in hot water and deflates when the bottle is in cold water.

Interpretation:

The teacher explains that **in hot water**, the air inside the bottle warms, expands and rises, which inflates the balloon. **In cold water**, the cold air falls, deflating the balloon.

FIG. 29
Student notebook. Experiment 2 on the effects of temperature difference.

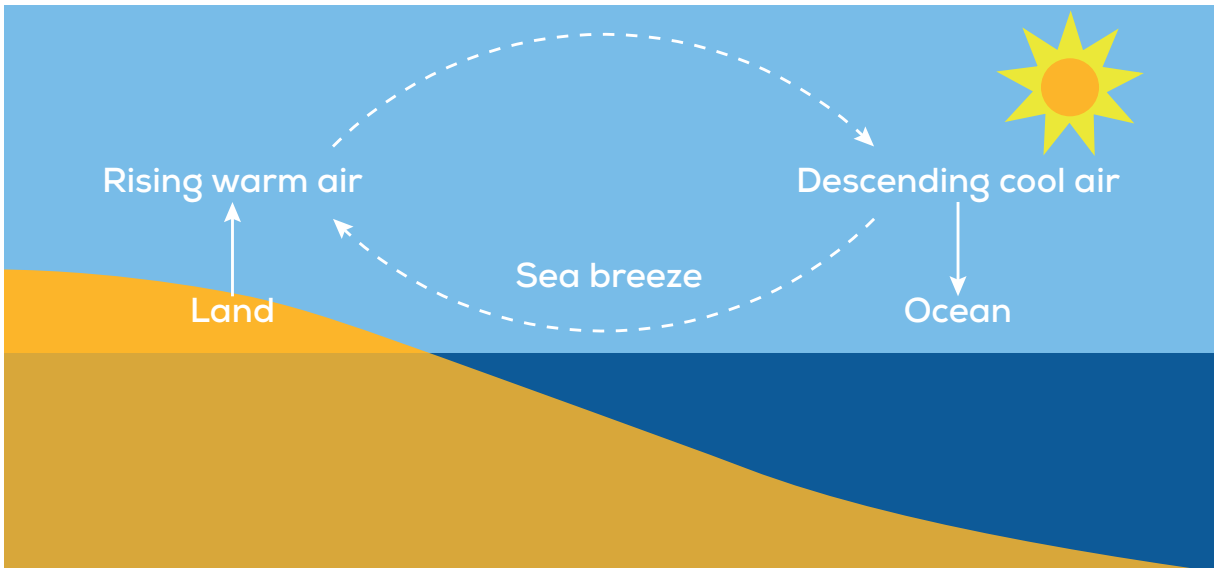


THE CONNECTION WITH WIND FORMATION

The teacher and the students discuss the results of the two experiments to try and identify how wind is created:

- The sun heats one part of the atmosphere differently to the other parts
- When the earth is heated by the sun, the air warms up, expands and rises into the atmosphere, causing pressure to drop in warm areas compared to cooler areas
- The air in cold areas cools and sinks creating high pressure
- Air always moves from high pressure to low pressure areas and this movement of air is wind (Fig. 30)

FIG. 30



PART II AERODYNAMICS

COMPETITION:

The blades in a modern wind turbine have a shape that is similar to the wings of an airplane. To understand the interaction between the wind and wind turbine blades, the teacher can set up a competition between the students to show how an airplane is able to fly:

In teams of two, students build a paper plane and make it fly as far as possible.

- The competition takes place in a corridor of the school, sheltered from the wind
- The students will find that some airplanes fly farther than others
- The students measure the distance covered by their planes and put together a table to compare results

** This exercise can also be an opportunity to work on or review length measurements.*

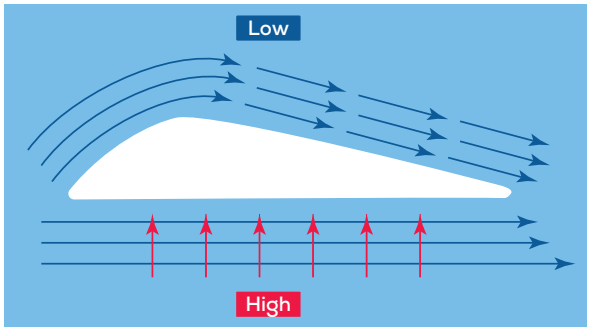
RESEARCH QUESTION:

Teacher asks the students:

Why do some airplanes fly farther than others?

To answer this question, the students should try to come up with hypotheses by comparing the paper airplane with a real airplane.

FIG. 31
Cut section of wind turbine blade has one flat side and one more rounded side.



HYPOTHESES

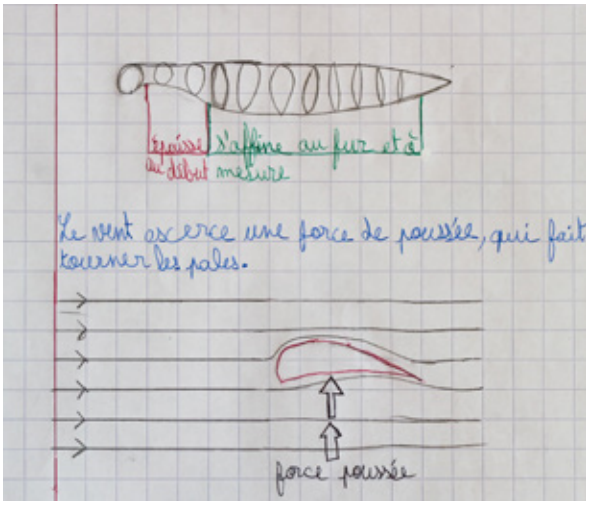
TABLE 6
Examples

PAPER AIRPLANE	REAL AIRPLANE
• Thin and light. • Pointed at the end. • The shape of the wings is important. • The wings are symmetrical.	• The wings are rounded at the top and flat at the bottom: depression. • Air pressure lifts the plane.

EXPLANATION:

- The wind in picture 31 below travelling around the longer, curved edge creates a lower pressure pocket while the wind below stays at the same pressure, creating a pressure imbalance compared with the wind above
- Wings are shaped in such a way that air flows more quickly across the top of the wing. When air travels more quickly, its pressure decreases. Thus, the pressure at the wing's top is less than the pressure at the wing's bottom. The pressure differential acts as a lifting force
- On a wind turbine, the lift on the blades drives its rotational motion, creating a torque that balances the torque at the generator

FIG. 32
Student notebook. The lifting force creates a rotational force and causes the blades to spin.



STEP 3
Studying the global wind map and wind types

- Students take a look at the global wind map e.g. the wind maps taken from January and February 2021
- They write down the names of local winds
- The teacher prepares a fact sheet for each local wind
- He/she places these fact sheets in different places along the corridor of the school
- Students summarise the fact sheets individually, in the form of a text or a mind map. To do this, they move quietly around the corridor reading the teacher's descriptions, leaving their writing sheet on the bench. They record as much information as they can and write it down on their sheet. Students can visit each fact sheet a maximum of three times

Example of a student's text summary of the local wind fact sheets:

- The **Sirocco** is a strong wind from Africa. It originates in Algeria, Morocco and Tunisia and can reach Greece, Sicily, Corsica and sometimes as far as the Alps. It can reach speeds of up to 100 km/h
- The **Harmattan** is a wind that flows across East and Northeast Africa. It carries a lot of sand which can often hinder the view of airplanes. The Harmattan is a winter wind that blows from December to January. When it blows, the days are very hot but the nights are very cool
- The **Alizé** is a regular wind that blows between the tropics. In the northern hemisphere, it blows northeastward and south of the Equator, it blows southwestward
- A **blizzard** is a snowstorm combined with strong winds. It reduces visibility to just a few metres
- **Tropical cyclones**: a cyclone is a tropical storm with thunderstorms and large cloud systems. These clouds and winds begin to circle around the eye of the cyclone, an area of calm weather. This storm moves forward and devastates everything in its path

FIG. 33
Map of well-known global winds.

STEP 4
History of wind

The students should start by asking questions about the role of wind in history:

- beliefs;
- uses of wind;
- legends;
- wind-related inventions;
- wind musical instruments...

RESEARCH ASSIGNMENT

Each team of 3 or 4 students should select a historical period or a civilisation they want to focus on for their research on wind, covering aspects such as beliefs, uses for wind, legends, inventions related to wind, etc. Examples of possible historical periods and civilisations include:

- Ancient Egypt
- Ancient Greece
- The Roman Empire
- The Vikings
- The Middle Ages
- The Modern Era

Each team creates a poster with the most important information and pictures to summarise their research findings. They can then present it to the rest of the class. The posters are then placed on the classroom timeline.

FIG. 34
Student poster on wind in Ancient Egypt. It describes:

- *Wind-related Inventions: Wind towers; windmills; sailing boats.*
- *Wind instruments used: flutes; clarinets; trumpets; oboes.*
- *Wind-related beliefs: Horus, God of wind; Amun, God of the sun and wind; Amonet, Goddess of wind; Seth, God of thunder.*
- *The Egyptians used felucca to sail on the River Nile.*

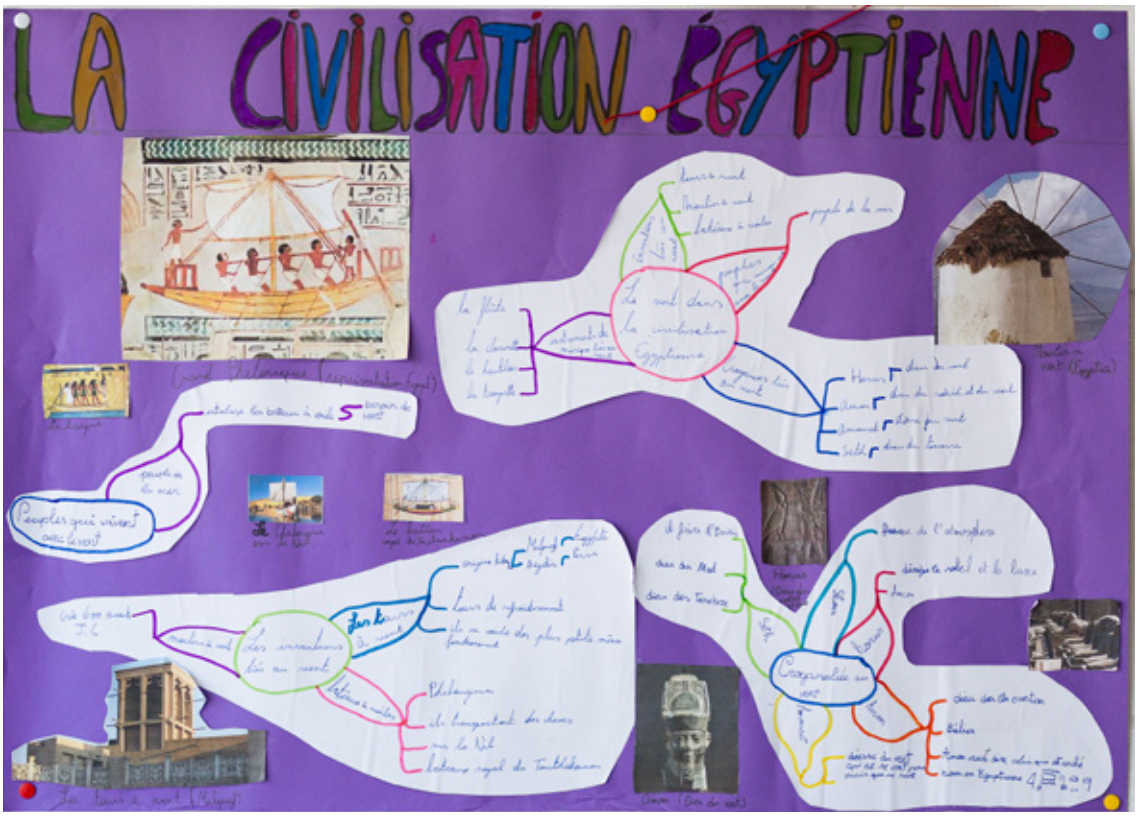


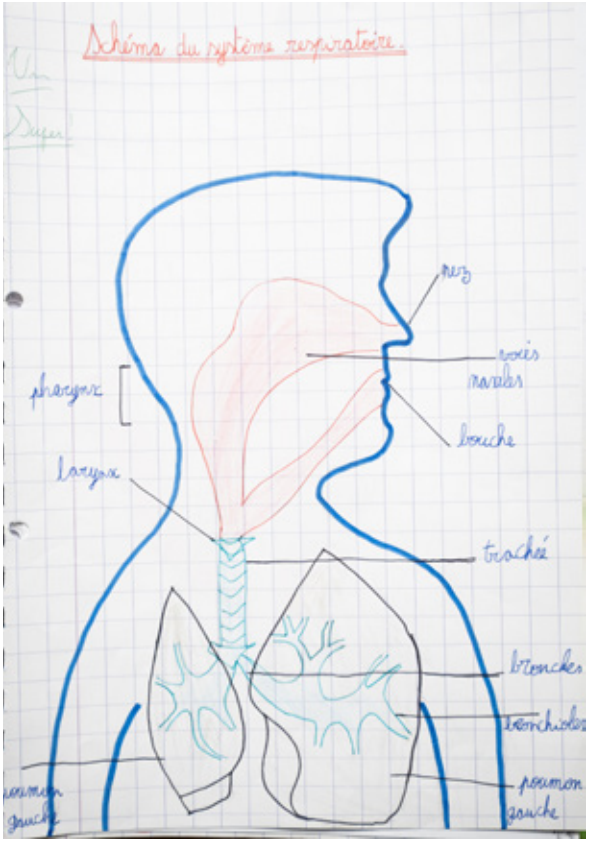
FIG. 35
Each poster is then placed along a classroom timeline.

STEP 5
Studying the respiratory system

To make the curriculum easy to understand, the teacher can use the subject of wind to teach students about the respiratory system. In their previous research assignments, the students saw examples of different wind instruments across world history. We use our respiratory system to power these wind instruments.

- Students make an initial diagram showing what they know or how they think the respiratory system works
- To back this up, they do a dissection of a pig's lung
- Each student makes a drawing of the lungs and describes it in the form of a text
- Students carry out research about the lung and the respiratory system and make their own summaries with pictures

FIG. 36
Initial representations of the respiratory system.



SUPPORT MATERIAL FOR THE TEACHER

This Toolkit offers support material for the teacher to help implement the curriculum. It was prepared by wind energy experts and is meant to inform the teacher about the subject area of each module. This will help the teacher to plan out his/her lesson and to help them pass on this knowledge to the students. Activities in this material should make use of recycled and affordable material.

The support material contains the following and can be downloaded here

Theoretical aspects

- The concept of energy, its types and forms
- The concept of aerodynamics, how it explains the shape of wind turbine blades and their interaction with wind
- The concept of air and atmospheric pressure
- The European Wind Atlas
- How do we measure wind?
- Basic components of a wind turbine

Classroom activities & experiments

- Forms of energy
- Energy transformation
- Atmospheric pressure and wind formation

Classroom discussions

- Renewable versus non-renewable sources of energy; their advantages and disadvantages

YouTube videos

- Virtual tours inside and outside a wind turbine

Step-by-step guides and instructions

- Building a cup anemometer and taking measurements
- Building a wind turbine and making it spin
- Making a wind vane and finding the wind direction

To find out more you can use the following resources:

School resources:

- Wind with Miller
- Alliant Energy Kids
- Energy student resources
- NEED Curriculum Resources
- Wind for Schools

WindEurope LearnWind free resources:

- **Let the wind blow** book & video
  Explains climate change & wind energy
- **When I Grow up** book
  Inspires young adults to consider a career in clean energy
- **Wind Energy Basics** animation
  Teaches users about wind energy technology
- **Offshore Wind 4 Kids** workshops
  Demonstrates how offshore wind turbines work

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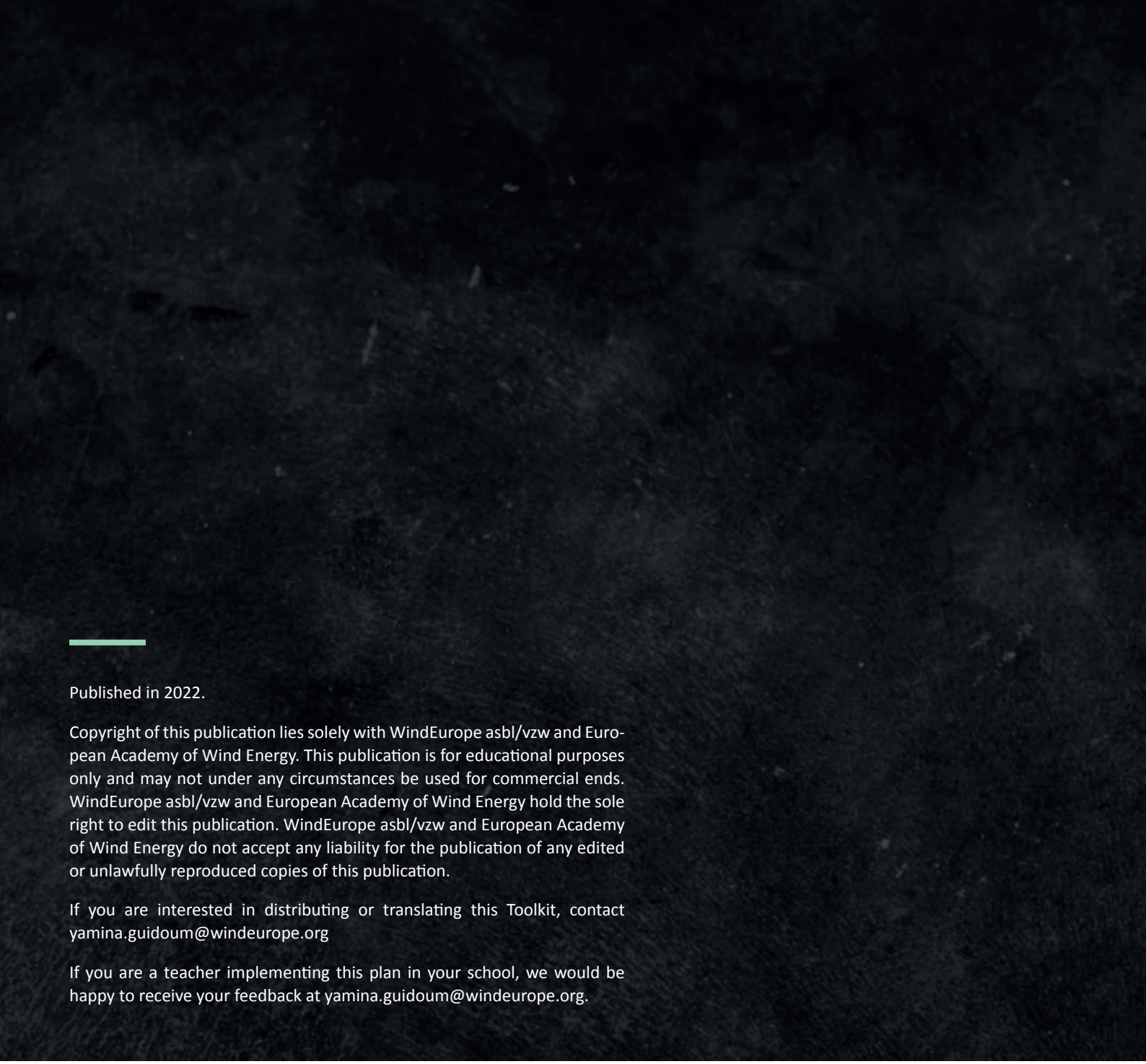

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If you are interested in distributing or translating this Toolkit, contact yamina.guidoum@windeurope.org

If you are a teacher implementing this plan in your school, we would be happy to receive your feedback at yamina.guidoum@windeurope.org.

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