

Understanding wind turbine technology

Learning scenario



About this learning scenario

"Understanding wind turbine technology" is one of four learning scenarios developed as part of the adaptation of the **WindEurope Teacher Toolkit for Primary Schools**, carried out by **European Schoolnet (EUN)** in partnership with **WindEurope**, within the framework of the **Scientix® STEM Alliance** initiative. [Learn more about this partnership here.](#)

WindEurope's teachers' toolkit: Learning wind energy in primary schools

The **WindEurope Teacher Toolkit for Primary Schools** is an educational resource developed by **WindEurope**, in partnership with **Singelijn Primary School in Brussels**, to help primary school teachers, particularly those teaching the final years of primary education, introduce students to the fundamentals of wind energy. The toolkit provides practical materials that connect renewable energy topics with classroom learning and aims to make wind energy accessible to young learners without requiring any prior background knowledge from teachers or students.

The toolkit comprises **four cross-disciplinary modules**, each structured as a lesson plan with interactive activities and supplementary resources. The modules link subjects such as science and technology, mathematics, history, geography, and language learning with real-world wind energy topics, helping students understand how renewable energy relates to everyday life and global sustainability challenges.

The toolkit was **piloted with a class of 12-year-olds (6th grade) at Singelijn Primary School in Brussels between November 2020 and April 2021**. The curriculum was co-designed by the teacher and a class of 20 students and adapted to match their learning objectives and interests. The resource is available in **Danish, Dutch, English, French, Polish and Spanish**, and was reviewed by the **Science Communication Committee of the European Academy of Wind Energy**.

[Access the Toolkit here.](#)

From toolkit to learning scenarios: The adaptation

The four original modules have been reviewed and adapted using the Scientix® methodology – a pedagogical quality review process that supports the development of high-quality STEM resources for teachers across Europe. The original toolkit provides engaging classroom activities about wind energy. The adapted learning scenarios retain these activities while enriching them with pedagogical guidance, curriculum mapping, assessment strategies, and links to European STEM and sustainability education frameworks. **As a result, teachers receive not only ready-to-use classroom activities, but also complete, curriculum-ready teaching resources that are easier to integrate into classroom practice across different European education contexts.** The adaptation also introduces three key enhancements:

1. Integration of GreenComp: Each learning scenario has been mapped to relevant competences from GreenComp, the [European Sustainability Competence Framework](#) developed by the European Commission's Joint Research Centre. GreenComp defines 12 competences organised into four areas –



Embodying Sustainability Values, Embracing Complexity in Sustainability, Envisioning Sustainable Futures, and Acting for Sustainability – to help learners of all ages develop the knowledge, skills, and attitudes to think, plan, and act sustainably.

2. Integration of industry involvement: Real-world industry applications have been embedded into each learning scenario. This includes profiles of wind energy professionals and the diverse roles they play – from engineers and environmental scientists to project developers and grid specialists – as well as references to real wind energy sites and technologies, examples of how wind turbines are designed, built, and tested, and connections to the broader challenge of the energy transition and Europe's path to climate neutrality. This aims to inspire curiosity, demonstrate the relevance of STEM subjects, and motivate young learners to imagine their future in these fields.

3. Mapping to the Scientix STEM School Label (SLL) criteria: The adaptation includes mapping activities to the SLL criteria, allowing school leaders and teachers to see how each learning scenario addresses key STEM areas and competencies and how it can fit into their school's STEM strategy. To learn more about the Scientix STEM School Label, [visit this page](#).

European Schoolnet (EUN) developed the pedagogical adaptation of this resource and takes full responsibility for the pedagogical adaptation and the pedagogical and STEM-educational content introduced through this adaptation.

The four learning scenarios

The scenarios are intended to be used in sequence but can also be used as stand-alone resources. They can be accessed below.

1. Learning about energy.
2. Constructing an anemometer and taking measurements.
3. Understanding wind turbine technology.
4. Learning about wind.

Project partners

This learning scenario has been made possible through the collaboration of key partners. [WindEurope](#) is the voice of the wind energy sector in Europe, promoting wind energy as a key part of the transition to a sustainable energy system. By joining the Scientix® STEM Alliance, WindEurope connects classrooms with real-world renewable energy examples, supporting STEM learning, inspiring young learners, and highlighting potential career pathways in the sector. [European Schoolnet \(EUN\)](#) is a network of over thirty Ministries of Education across Europe, supporting schools and teachers in the adoption of innovative teaching practices, professional development, and evidence-based approaches to learning for the 21st century. [Scientix®](#) is Europe's largest STEM education community, connecting teachers, researchers, and policymakers through training, resources, and collaborative projects. The [Scientix® STEM Alliance](#) enables industry partners to actively contribute to STEM education, engage directly with educators, and support the development of innovative teaching practices across Europe.



Learning scenario ID

Title

Understanding wind turbine technology

Summary

This learning scenario engages students in an authentic engineering investigation into wind turbine technology. Across five lessons, students explore how wind turbines generate electricity (Lesson 1), design and build a model wind turbine (Lesson 2), test and refine their prototype (Lesson 3), evaluate its performance through scientific investigation and data analysis (Lesson 4), and connect their learning to real wind turbines, careers in the wind energy sector, and renewable energy (Lesson 5). By the end of the project, students apply engineering design, scientific inquiry, and mathematical reasoning while developing STEM knowledge and sustainability competences.

Keywords

Wind energy, wind turbine, renewable energy, engineering design process, scientific method, inquiry-based learning, STEM, sustainability, blade design, energy transition, GreenComp.

Aim of the lesson

By the end of this learning scenario, students will be able to:

- Explain how a wind turbine converts wind into electricity.
- Apply an engineering design process to build and refine a working model turbine.
- Use scientific inquiry skills – hypothesis-forming, fair testing, and data recording and interpretation – to evaluate the effect of design changes on performance.
- Connect their findings to real wind energy careers and to the wider role of renewable energy in a sustainable future.

Licence

This learning scenario is licensed under the [Creative Commons Attribution–ShareAlike 4.0 International \(CC BY-SA 4.0\) licence](#). Others may copy, share, and adapt the material, including for commercial purposes, provided they give appropriate credit, indicate if changes were made, and distribute any adapted material under the same or a compatible licence.

Note for Educators: You are welcome (and encouraged!) to translate, adapt, and customise the worksheets and text for use in your own classroom.

Please note regarding images: Unless otherwise indicated, the images and icons in this learning scenario are sourced from the Canva content library and are used in accordance with [Canva's Content License Agreement](#). Other visual



assets are used under their respective licences. The CC BY-SA 4.0 licence applies to the text and original instructional content, but not to third-party visual assets, which remain the property of their respective rights holders and should not be reused separately unless their licence permits it.

Overview

Subject(s)	Science, Mathematics, Technology		
Topic(s) and curriculum connections	This learning scenario connects to curriculum areas commonly found in upper-primary education across Europe. The curriculum connections were developed through a review of representative upper-primary curricula from several European countries to identify shared learning objectives and curriculum strands, rather than align the resource to a single national curriculum. Teachers can use these strand descriptions to identify the relevant sections of their own national or regional curriculum and adapt the activities accordingly.		
	Subject	What is covered	Curriculum connections across European countries
	Natural Science (Lessons 1, 3, 4 and 5)	- Wind as a natural phenomenon and renewable energy resource. - How a wind turbine converts kinetic energy into mechanical and then electrical energy. - The function of turbine components. - Scientific enquiry – forming and testing a hypothesis, changing one variable at a time (blade shape or length), collecting, recording and comparing timed results. - Interpreting class data as evidence. - Connecting scientific evidence to real-world energy decisions and to the wider energy transition.	1) Scientific enquiry / working scientifically: observing, predicting, measuring, recording, comparing and communicating findings. 2) Forces, motion and energy: energy forms and transformation, wind as a renewable energy source, energy supply systems. 3) Environmental awareness and sustainability: connecting renewable energy to environmental impact, climate and human wellbeing.
	Technology (Lessons 1–3) ¹	Engineering design process: choosing and justifying a blade design, building a model turbine from simple and recycled materials, testing and troubleshooting, refining a prototype based on evidence.	1) Design and make / engineering design: applying a structured design-build-test-improve cycle to create a functional artefact. 2) Understanding technological systems:

¹ Subject boundaries vary across European education systems. In particular, Technology at upper-primary level is often integrated within science or broader STEM learning rather than taught as a standalone subject. The curriculum connections presented in this learning scenario therefore refer to the intended learning outcomes and curriculum strands, regardless of how these are organised within a particular national or regional curriculum.



		- Understanding how a wind turbine works as a machine that converts energy. - Connecting the design process to real professional practice in the wind energy sector.	recognising that scientific principles underpin the design of real instruments and machines used by professionals.
	Mathematics (Lessons 3–5)	- Timing turbine performance with a stopwatch, recording results in a table, calculating the average of repeated trials, comparing numerical data across groups and across the class. - Representing class results as a bar chart. - Applying division and ratio to a real-world problem (turbine cost and annual saving).	1) Measurement and data handling: using standard units and timers, recording, averaging and representing data, comparing quantities. 2) Number and calculation: multi-step calculations, division and ratio applied to a real-world context. 3) Mathematical reasoning in context: interpreting results, explaining differences between predictions and outcomes, discussing patterns and possible sources of error.
A full assessment framework linked to these curriculum strands – including subject-specific descriptors at three levels of achievement – is provided in the Assessment section .			
Age of the learners	11–12 years old.		
Preparation time	Approximately 1–2 hours across the five lessons.		
Total implementation time	5 lessons of 45 minutes each.		
Teaching material	Lesson 1 – What is a wind turbine? Annex 1: K-W-L-H chart – student worksheet (print one per student). Annex 2: How does a wind turbine work – student worksheet (print one per student). PowerPoint – The turbine quiz game. - Video – ACCIONA. (2016, February 23). <i>How does a wind turbine work?</i> YouTube. https://www.youtube.com/watch?v=DILJWsFI3w. (2:46). Lesson 2 – Build a wind turbine Annex 3: Blade design card – student worksheet (print one per group or one per student). Annex 4: Building instructions – group worksheet (print one per group). - Video – STEAM Powered Family. (2025, May 25). <i>Simple Wind Turbine Project - Elementary Science Fair and STEM Project</i>. YouTube. https://www.youtube.com/watch?v=4mRh6SeelYw. (4:12). - One building materials station per group containing: cylindrical cardboard tube (e.g. Pringles can), wooden skewer, card stock, scissors, ruler, marker, string, drinking straw, masking tape, pencil, strong adhesive (double-sided		



tape recommended), sand/pebbles/marbles for ballast, paper cup containing a prepared 20 g load, access to a class fan.

Lesson 3 – Finish building, predict and first test

- [Annex 4: Building instructions](#) (reuse)
- [Annex 5: Grand Challenge – Results and scientific analysis](#) (one per group)
- Sticky notes (Prediction Wall)
- Fan
- Spare card stock, masking tape and adhesive for refinements

Lesson 4 – Grand Challenge and scientific analysis

- [Annex 5: Grand Challenge – Results and scientific analysis](#) (reuse)
- Prediction Wall
- Fan
- Stopwatch or timer

Lesson 5 – Real turbines, real people

- [Annex 1: K-W-L-H chart](#)– student worksheet (reuse).
- [Annex 6: Video – Inside a real wind turbine](#) (print one per student).
- Video – William Lyons. (2012, September 16). *Wind Turbine Tour*. YouTube. https://www.youtube.com/watch?v=8wK1qmRv_l8. (12:51).

The learning scenario activities

Activity plan

Name	Procedure	Duration	STEM & GreenComp Alignment ²
Lesson 1: What is a wind turbine? Science Technology	Activity 1: K-W chart – What do you already know? (5 min) Distribute Annex 1 : K-W-L-H chart. Students individually complete only the K box (What I KNOW) and W box (What I WONDER). Collect responses or invite two or three students to share aloud. Do not correct misconceptions yet - they will surface and resolve through the lesson. Activity 2: Video – How a wind turbine works (10 min) Guiding question (write on the board): <i>How does moving air become electricity that powers our homes?</i>	45 min	SSC 1.3 SSC 2.3 GC 1.1

² Each lesson is tagged with codes referring to the STEM Strategy Criteria (SSC) and GreenComp (GC) competences it addresses. SSC codes relate to the Scientix STEM Strategy Criteria, a framework used to identify and support high-quality STEM teaching practice across schools in Europe. GC codes relate to GreenComp, the European Sustainability Competence Framework developed by the European Commission's Joint Research Centre. A full explanation of each code, along with how this learning scenario addresses it, is provided in the "Reflection on Practice" section at the end of this document.

Name	Procedure	Duration	STEM & GreenComp Alignment ²
	Distribute Annex 2: How and play a video showing an animation of how a wind turbine works (e.g., suggested video). Students complete Part A while watching – key words only, not full sentences. Pause the video each time a new component appears on screen. Give students 20–30 seconds to write their notes before pressing play again. At each pause, ask one student to read back what they wrote – this keeps the class on track and helps students who missed something catch up. Activity 3: The turbine quiz game (30 min) Divide the class into 4 teams. Explain that over the next three lessons they will design, build and test their own wind turbine. In the Grand Challenge, teams will compete to lift a 20 g load as quickly as possible. The winning team in today's quiz will earn a Grand Challenge Advantage: during the build phase, they may ask the teacher for one engineering hint if they get stuck or are unsure how to improve their design. The teacher provides guidance through a question or suggestion rather than solving the problem for them. Teams take turns choosing a tile from the game board and earn points by correctly identifying and placing wind turbine components, with bonus Advantage and Challenge cards adding variety along the way. The complete game, including the interactive game board, instructions and scoring, is provided in the accompanying interactive PowerPoint. As the components appear, students also place them in their worksheet (Annex 2 – Part B and C). When all tiles have been revealed, teams total their points. The team with the highest score is the Turbine Quiz Champion. If there is a tie, tied teams have 20 seconds to write down as many wind turbine components as possible without looking at their worksheet. The team with the most correct components wins. Conclude by reminding students that every component and process they identified today will be used when they design, build and test their own turbine during the Grand Challenge. Ask students to keep their Annex 2 safely – they will use it in the next lessons. Collect Annex 1 to return at the end of the scenario.		
Lesson 2: Build a wind turbine	<u>Before the lesson: Teacher preparation</u>	45 min	SSC 1.2 SSC 2.1



Name	Procedure	Duration	STEM & GreenComp Alignment ²
Technology	Watch the construction video before the lesson. Set up one materials station per group (refer to Overview table). Print one copy of Annex 3 (Blade Design Card) per student and one copy of Annex 4 (Build Guide) per group. Pre-punch the axle holes in each group's cardboard tube. Activity 1: Recap and mission launch (5 min) Open with: <i>Last lesson you became experts on wind turbines. Today you will become engineers.</i> Ask three rapid-fire questions to the class – hands up, no worksheets. For example: • <i>What is the name of the box at the top of the tower that houses all the main components? (Nacelle).</i> • <i>Name one component you would find inside the nacelle. (Any of: gearbox, generator, shafts).</i> • <i>What does the generator do? (Converts kinetic/mechanical energy into electrical energy).</i> Then reveal the Grand Challenge for the first time in full. Write or project this on the board and leave it there for the rest of the lesson: THE GRAND CHALLENGE Build a wind turbine from recycled materials. Make it lift a 20 g mass as fast as possible. Fan distance: 50 cm. Your best time will be recorded. The fastest turbine wins. Remind students that the team who won the Turbine Quiz last lesson has a Grand Challenge Advantage: at any point during the build or refinement process, they may ask the teacher for one engineering hint. Activity 2: Blade design card (10 min) Distribute Annex 3. Explain that all groups will build the same turbine structure (tower, hub and axle), but they must choose their own blade shape and length. In groups, students decide on a blade design. Circulate and ask each group one question, such as: <i>Why did you choose that blade shape?</i> or <i>What do you think will happen if you use longer blades?</i> Encourage students to justify their choices before building rather than focusing on getting the ‘right’ answer. Activity 3: Build (30 min)		SSC 2.2 GC 2.1 GC 3.3



Name	Procedure	Duration	STEM & GreenComp Alignment ²
	Groups build independently using Annex 4 as the primary guide. Students may also use a video as visual support (see Overview table for recommended videos). Students test components as they build and make adjustments when needed. The teacher circulates, supporting groups through questioning rather than direct instruction (e.g. <i>What do you think is causing this issue?</i>). Encourage the use of appropriate engineering vocabulary throughout the activity, including <i>axle</i> , <i>hub</i> , <i>pitch angle</i> , <i>bearing</i> , <i>rotor</i> , and <i>prototype</i> .		
Lesson 3: Finish building, predict and first test Science Technology Mathematics	<u>Before the lesson: Teacher preparation</u> Ensure all materials stations are still set up. Have masking tape and spare card stock available for groups that need to fix or adjust their turbine. Prepare a space on the board for the Prediction Wall. Have the fan ready at the testing station, along with one shared string (20–30 cm) and 20 g mass – this will be attached to each turbine by the teacher at test time, instead of using whatever string groups tied on during construction, so results are comparable across groups from Run 1 onward. <u>Activity 1: Finish the build (15 min)</u> Groups retrieve their turbines and continue building from where they stopped in Lesson 2. <u>Activity 2: Prediction wall (5 min)</u> Before any fan testing, give each group one sticky note. They predict how long they think their turbine will take to lift the 20 g mass, choosing one: ☐ Under 10 seconds ☐ 10-20 seconds ☐ 20-30 seconds ☐ Over 30 seconds Post all predictions on the board. Do not discuss yet – they will be revisited in Lesson 4. <u>Activity 3: First test – Run 1 (10 min)</u> Fan on. Each group gets 60 seconds. Record the result in Annex 5 Part A under Run 1 (Baseline) – time in seconds, or DNL (Did Not Lift). <u>Activity 4: Refinement – One targeted change and run 2 (15 min)</u> Groups look at their Run 1 result and make exactly one change – either blade shape or blade length. Blade angle is not a variable in this experiment and should not be changed. Before touching anything, they record their hypothesis in Annex 5 Part A:	45 min	SSC 1.3 SSC 3.1 GC 2.2 GC 3.2



Name	Procedure	Duration	STEM & GreenComp Alignment ²
	We changed _____ (blade shape / blade length) from _____ to _____ because we predict this will _____. If a group wants to change multiple things, ask: <i>If you change two things and your result improves, how will you know which change made the difference?</i> After making the change, each group runs Run 2 (Refinement) and records the result in Annex 5 Part A. This is a refinement test, not the Grand Challenge. The official competition happens in Lesson 4. Real-world link: The first commercial offshore wind turbine was installed in 1991 and produced 0.45 MW. Today's largest turbines produce over 15 MW. Engineers achieved these improvements through repeated cycles of testing, analysing results and refining their designs.		
Lesson 4: Grand Challenge and scientific analysis Science Mathematics	<u>Before the lesson: Teacher preparation</u> Mark exactly 50 cm from the fan to the turbine position with tape. Set the fan to its highest speed setting – do not change this at any point during the lesson. Project the Class Results Table (Annex 5 Part C). Print Annex 5, one per group. Keep the Prediction Wall visible on the board. <u>Activity 1: The grand challenge – Run 3 (25 min)</u> Read the rules aloud before starting: 1. Fan placed exactly 50 cm from every turbine, set to the highest speed setting. Measure before each run. Fan speed does not change. 2. The same string and 20 g mass are used for every turbine, attached by the teacher immediately before each test. 3. The turbine must stand freely – no hands during the test. 4. Timing starts when the fan switches on and stops when the 20 g mass is fully lifted. 5. Mass not lifted within 60 seconds: record DNL. This is valid scientific data. 6. Each group gets three official attempts. Record the result of each attempt in Annex 5 Part B, then calculate the average. This average becomes the group's official Grand Challenge result. If time is limited, groups may complete two attempts and calculate the average of those results instead.	45 min	SSC 1.3 SSC 2.2 SSC 3.1 GC 2.1 GC 2.2



Name	Procedure	Duration	STEM & GreenComp Alignment ²
	After all groups have completed their attempts, students transfer their average Run 3 result to the Class Results Table (Annex 5 Part C). Announce the Grand Challenge Champion based on the fastest average time. Activity 2: Revisit the prediction wall (5 min) Read out the closest prediction and the furthest. Ask: <i>Whose prediction was closest? What did you know – or not know – when you made it?</i> Activity 3: Scientific analysis (15 min) Groups work through Annex 5 Part E together. <u>Part 1 – Variables:</u> Groups identify the independent variable (what they changed between Run 1 and Run 2), the dependent variable (what they measured), and controlled variables (what they kept the same). <u>Part 2 – Interpreting the class results:</u> Using the full class results table, groups represent the class average Run 3 results as a bar chart – one bar per group showing their Run 3 time, coloured or labelled by blade shape. DNL results are shown as an empty bar with a label. Once the chart is complete, groups compare their results with those of the rest of the class. Ask: • Which group had the fastest and slowest average times, and what blade shape and blade length did they use? • Do any similarities or differences stand out between groups with similar blade shapes or blade lengths? Remind students that, with a small class dataset, one unusual result can sometimes appear to be a pattern even though it may simply be due to chance or another factor. Encourage groups to suggest possible explanations for any unexpected results using evidence from the graph. <u>Part 3 – Peer feedback:</u> Groups visit one other group's turbine and complete the peer feedback section – one strength and one suggestion, both with scientific reasoning.		
Lesson 5: Real turbines, real people Science Mathematics	Activity 1: Complete the K-W-L-H chart (5 min) Return Annex 1. Students now complete the L box (What I LEARNT) only. Invite two or three students to share something they learnt that surprised them.	45 min	SSC 2.3 SSC 6.1 GC 1.1 GC 3.1 GC 4.3



Name	Procedure	Duration	STEM & GreenComp Alignment ²
	Bridge to the rest of the lesson: <i>Over the last four lessons, you have learnt how wind turbines work and how engineers test designs and improve them using data. Today, you will see those same components inside a real operating turbine and meet some of the people who build, maintain, and operate them.</i> Activity 2: Video – Inside a real wind turbine (25 min) Distribute Annex 6. Explain that students will watch a guided tour inside a real 850 kW wind turbine at a school in Ireland. Their task is to record answers to the questions as they watch. Play the video (see suggested video in the Overview table), pausing at the five timestamps shown in Annex 6. Give students 30–45 seconds at each pause to complete their notes before continuing, and then review the answers together as a class. After the video, ask: <i>How many components did you recognise from the Turbine Quiz Game in Lesson 1?</i> Give students 90 seconds to write down every component they identified. Then, as a class, try to name all the components together. Activity 3: Meet the turbine technician (10 min) Lead a class discussion focused on the job of wind turbine technicians, using the video as the reference point. Use the following questions to guide the discussion: • <i>Before watching the video, what did you think this job looked like? Has anything changed?</i> • <i>What surprised you most about what the technician does in his job?</i> • <i>The turbine has been running since 2005 and needs to be serviced regularly to keep powering the school. What do you think would happen if there was nobody trained to look after it?</i> Activity 4: Reflection (5 min) Ask students to complete the H box (How I Might USE This) in Annex 1. Frame the task briefly: <i>Renewable energy is one of the most important tools we have to respond to climate change – and it can also provide clean, locally produced energy for homes, businesses, transport, and other everyday needs. The people who maintain and operate wind turbines play a real role in making this possible. Now that you understand how wind energy works, how might you</i>		



Name	Procedure	Duration	STEM & GreenComp Alignment ²
	<i>use this knowledge in your daily life, in future studies, or in the choices you make? What other ways can you think of that renewable energy is used in our daily lives and communities?</i> Invite two or three students to share before finishing. Alternative / Extension: Visit a real wind farm If there is a wind farm near your school, consider organising a visit as an alternative or extension to Activity 2, either in place of the video or as a follow-up trip later in the term. For guidance on organising an educational visit and finding the appropriate contacts, visit WindEurope's Education page. You can also use WindEurope's Meet our Members page to find national wind energy associations and their websites: • WindEurope – Education – Information and contacts to help schools organise educational activities and connect with national wind energy associations. • WindEurope – Meet our Members – A directory of WindEurope members, including national wind energy associations, where you can find relevant organisations and their contact details.		

Assessment

Assessment in this learning scenario is continuous and integrated across all five lessons. Rather than relying on a single final task, students demonstrate their learning through hands-on construction, measurement, experimental investigation, and written reflection.

How to use this rubric. The assessment framework below is organised by subject and aligned with the curriculum strands presented in the [Overview table](#). For each competence, the table identifies the lesson activity or student artefact that provides evidence of learning, together with descriptors for three levels of achievement – **Beginning (1)**, **Developing (2)**, and **Proficient (3)**. The rubric is intended to support ongoing observation during practical and outdoor activities, provide structured feedback on written recording sheets, and evaluate students' progress across the full investigation.

Competence	Beginning (1)	Developing (2)	Proficient (3)
NATURAL SCIENCE (Lessons 1, 3, 4 and 5)			
Understand wind as an energy resource and how a turbine converts it to electricity Lesson 1: K-W chart, quiz game; Annex 2 Parts B–D	Names wind turbine components but cannot explain how wind becomes electricity	Describes the general sequence – wind turns the blades, which drives a generator – with some gaps in the explanation	Explains the full energy chain from wind to electricity accurately, using correct scientific vocabulary (e.g. kinetic, mechanical and electrical energy)



Competence	Beginning (1)	Developing (2)	Proficient (3)
Apply scientific inquiry skills Lesson 3: Annex 5 Part A (hypothesis); Lesson 4: Annex 5 Parts A–B	Records a result without forming a hypothesis or identifying variables	Writes a hypothesis and records Run 1 and Run 2 results; identifies the independent variable with some support	Writes a clear, testable hypothesis; correctly identifies the independent, dependent and controlled variables; explains why the result may differ from the prediction
Interpret class data and identify patterns Lesson 4: Annex 5 Part D (class graph)	Reads only their own group's result and does not compare it with the class	Identifies simple similarities or differences between a few groups' results	Uses the full class bar chart to identify patterns linking blade shape or length to performance, and suggests possible reasons
Connect evidence to real-world energy decisions Lesson 5: Annex 6; class discussion; Annex 1 (H box)	States an opinion about wind energy without referring to any evidence	Refers to the class turbine test or the video when discussing the value of wind energy	Uses class data, the real turbine case and the payback calculation together to make a well-reasoned argument about wind energy's role in sustainability, acknowledging limitations
TECHNOLOGY (Lessons 1–3)			
Apply an engineering design process Lesson 2: Annex 3 (Blade Design Card), Annex 4 (build)	Chooses a blade design without justification; needs significant support to build	Chooses and justifies a blade design; builds a turbine that mostly functions, with some support	Justifies design choices using engineering vocabulary (axle, hub, pitch angle, rotor); builds a fully functional turbine independently
Test, evaluate and refine a design using evidence Lesson 3: Run 1/Run 2 refinement; Annex 5 Part A	Cannot identify what to change, or why, after Run 1	Identifies one change to make after Run 1, with teacher support	Independently identifies a single, evidence-based change, predicts its effect, and explains the Run 2 result
MATHEMATICS (Lessons 3–5)			
Measure, record and interpret time data Lessons 3–4: Annex 5 Parts A–B	Records times inconsistently or incompletely	Records Run 1, 2 and 3 times accurately, with some support	Records all timed trials accurately, calculates the average Run 3 time correctly, including DNL results where appropriate, and uses the results to support conclusions
Solve a real-world numerical problem Lesson 5: Annex 6 (turbine cost €1,270,000; annual saving €120,000)	Cannot set up the calculation needed to solve the problem	Sets up and solves the payback calculation with support, reaching an approximate answer	Solves the payback calculation independently, shows working clearly, and checks that the answer is reasonable
Represent and compare quantitative data Lesson 4: Annex 5 Part B (class bar chart)	Cannot represent the class results as a chart	Represents the results as a bar chart with some inaccuracies	Accurately represents the average Run 3 results as a labelled bar chart and uses it to compare groups and identify patterns

Reflection on practice

This section explains how the learning scenario connects to established quality frameworks for STEM education ([Scientix STEM School Label](#)) and sustainability competences ([GreenComp, the European Sustainability Competence](#))



Framework developed by the European Commission's Joint Research Centre). For each criterion or competence addressed, you'll find a short explanation of where and how it is reflected across the four lessons. Teachers can use this section to understand the pedagogical reasoning behind the activities, identify the competences their students are developing, and see how the scenario can support their school's wider STEM or sustainability strategy.

STEM Strategy Criteria (SSC)

1. Instruction

☐ 1.1 Personalisation of learning

★ 1.2 Problem- and project-based learning (PBL)

★ 1.3 Inquiry-based science education (IBSE)

1.2 Students work towards the Grand Challenge by designing (Lesson 2), testing and refining (Lesson 3), and evaluating (Lesson 4) a model wind turbine that lifts a 20 g load.

1.3 Students make predictions (Lesson 3), test one variable at a time, analyse class results (Lesson 4), and use evidence to explain differences in turbine performance.

2. Curriculum implementation

★ 2.1 Emphasis on STEM topics and competencies

★ 2.2 Interdisciplinary instruction

★ 2.3 Contextualisation of STEM teaching

2.1 Students investigate energy conversion (Lesson 1), apply engineering design (Lessons 2–4), and use mathematical data analysis to evaluate turbine performance (Lesson 4).

2.2 Science, technology and mathematics are integrated through learning about energy conversion (Lesson 1), building turbines (Lessons 2–3), and interpreting experimental data (Lesson 4).

2.3 Activities are based on authentic wind turbine technology, culminating in a virtual tour of a real turbine and discussion of wind energy careers (Lesson 5).

3. Assessment

★ 3.1 Continuous assessment

☐ 3.2 Personalised assessment

3.1 Learning is monitored throughout the scenario using the K-W-L-H chart (Lessons 1 and 5), design justifications (Lesson 2), experimental results (Lessons 3–4) and reflection activities.

4. Professionalisation of staff

☐ 4.1 Highly qualified professionals

☐ 4.2 Existence of supporting (pedagogical) staff

★ 4.3 Professional development

4.3 The scenario supports teachers in implementing inquiry-based STEM through structured engineering, experimentation and sustainability activities across the five lessons.



5. School leadership and culture

- ☐ 5.1 School leadership
- ★ 5.2 High level of cooperation among staff
- ☐ 5.3 Inclusive culture

5.2 The scenario can be co-taught across science, technology and mathematics, particularly when combining turbine construction (Lessons 2–3), data analysis (Lesson 4) and career connections (Lesson 5).

6. Connections

- ★ 6.1 With industry
- ☐ 6.2 With parents/guardians
- ☐ 6.3 With other schools and/or educational platforms
- ☐ 6.4 With universities and/or research centres
- ☐ 6.5 With local communities

6.1 Throughout the learning scenario, students connect with the wind energy sector by exploring wind turbine technology (Lessons 1 and 5), engineering practices (Lessons 2–4), and careers in renewable energy (Lesson 5).

7. School infrastructure

- ★ 7.1 Access to technology and equipment
- ★ 7.2 High quality instruction and classroom materials

7.1 Students use fans, timers and engineering materials to design, build and test working wind turbine prototypes (Lessons 2–4).
7.2 The scenario provides videos, presentations, worksheets and engineering design guides to support each stage of the investigation.

GreenComp (GC)

1. Embodying sustainability values

- ★ 1.1 Valuing sustainability
- ☐ 1.2 Supporting fairness
- ★ 1.3 Promoting nature

1.1 Students reflect on the role of wind energy in a sustainable future and discuss how renewable energy aligns with sustainability values (Lessons 1 and 5).
1.3 Students recognise how replacing fossil fuels with wind energy can contribute to protecting ecosystems and supporting environmental sustainability (Lessons 1 and 5).

2. Embracing complexity in sustainability

- ★ 2.1 Systems thinking
- ★ 2.2 Critical thinking



★ 2.3 Problem framing

- 2.1 Students explore how wind, turbine design, electricity generation and sustainability interact as part of an interconnected energy system (Lessons 1–5).
2.2 Students assess experimental evidence, compare design solutions and justify conclusions about turbine performance using scientific data (Lessons 3–4).
2.3 Students investigate how engineering design can improve wind turbine performance as a contribution to the broader challenge of sustainable energy production (Lessons 2–4).

3. Envisioning sustainable futures

★ 3.1 Futures literacy

★ 3.2 Adaptability

★ 3.3 Exploratory thinking

- 3.1 Students explore how wind energy can contribute to future energy systems and consider the role of renewable technologies in creating a more sustainable future (Lesson 5).
3.2 Students modify and improve their turbine designs in response to testing results, adapting their solutions based on evidence (Lessons 3–4).
3.3 Students explore different blade designs and engineering solutions by combining science, mathematics and engineering through creative experimentation (Lessons 2–4).

4. Acting for sustainability

☐ 4.1 Political agency

☐ 4.2 Collective action

★ 4.3 Individual initiative

- 4.3 Students recognise how engineering and renewable energy can contribute to a more sustainable future and reflect on how they can apply this knowledge in their own lives (Lesson 5).



Annexes

Annex 1: K-W-L-H chart

Name:

Date:

K

What I KNOW

What do I already know about wind turbines or wind energy?

W

What I WONDER

What questions do I have? What do I want to find out?

L

What I LEARNT

What are my key findings after these lessons?

H

How I Might USE This

What might I do with this knowledge in the future?



Annex 2: How does a wind turbine work?

Name:

Date:

Part A – Watch the video and take notes

Suggested video: ACCIONA. (2016, February 23). How does a wind turbine work?

<https://www.youtube.com/watch?v=DILJJwsFI3w>

Watch carefully. For each component, write the key words you hear – where is it and what does it do?

Component	Where is it on the turbine?	What does the video say it does?
Wind vane		
Blades		
Hub		
Low-speed shaft		
Gearbox		
High-speed shaft		
Generator		
Transformer (at the base)		
Underground cables		
Substation		



Part B – Match each component to its definition

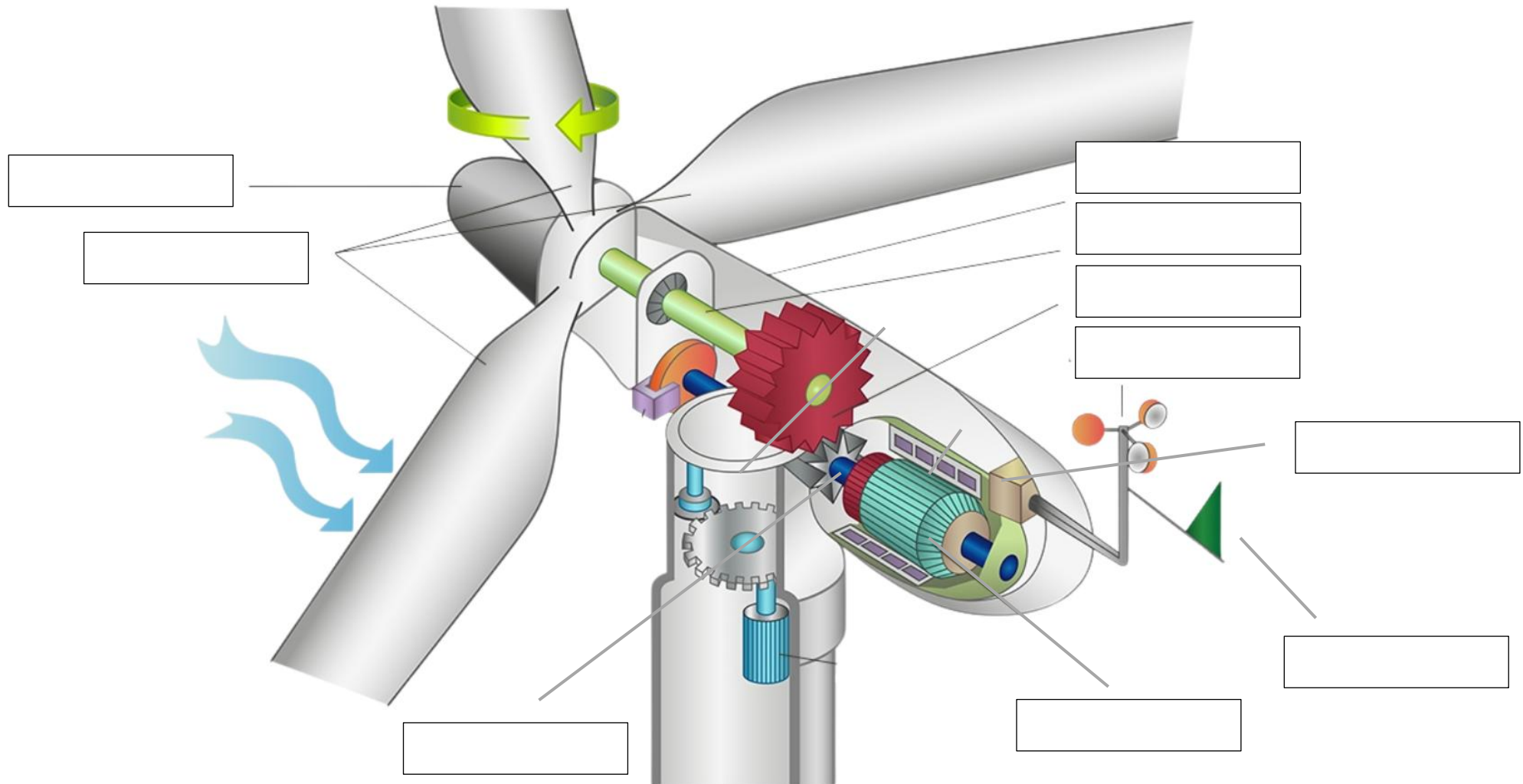
Write the correct component name next to each definition.

Component name	Definition
	Connects the blades to the low-speed shaft. It is the centre of the rotor.
	Measures wind speed and sends the information to the controller.
	Converts the turbine's rotation into electricity.
	The "brain" of the turbine. It monitors the turbine and starts or stops it when needed.
	Spins very fast (around 1,500 rpm) to drive the generator.
	Capture the energy of the wind and make the rotor turn.
	Increases the rotation speed so the generator can produce electricity.
	Detects which direction the wind is blowing and helps the turbine face the wind.
	Spins slowly with the blades and carries the rotation to the gearbox.
	The housing at the top of the tower that contains the main parts of the turbine, including the gearbox and generator.



Part C – Locate the components

Using your answers from Parts A and B, label the diagram below.

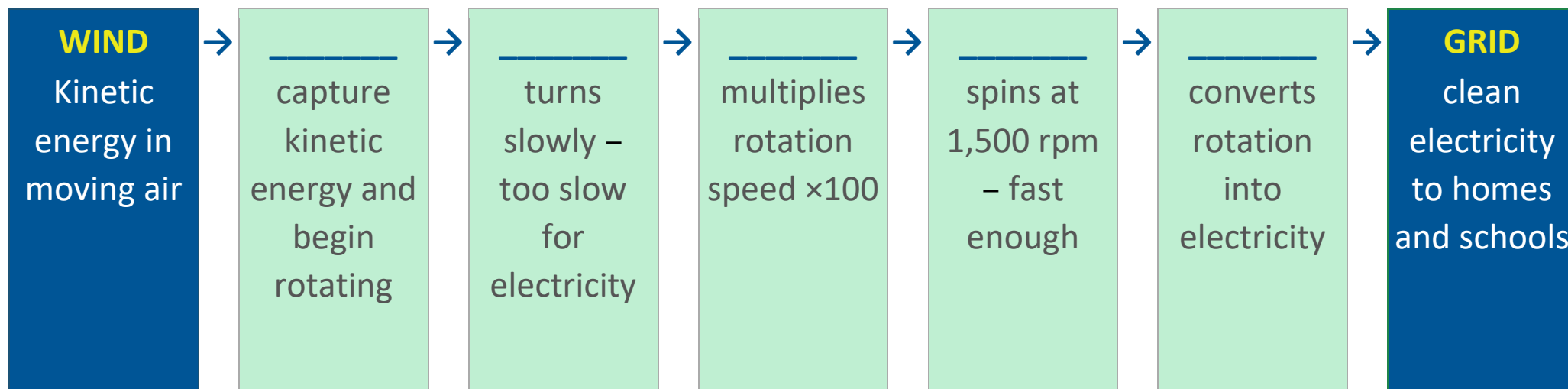


Wind Turbine – Inside View (<https://medienportal.siemens-stiftung.org/en/wind-turbine-inside-view-101588>). © Siemens Stiftung 2018, licensed under CC BY-SA 4.0 International.



Part D – Complete the energy chain

Complete the energy chain below by identifying the turbine components that transfer energy from the wind to the electricity grid.



Annex 3: Blade design card

Name:

Group:

The turbine tower, hub and axle are built the same way by everyone. Your engineering decision is the blade design. Choose ONE option in each row and record your justification below.

Variable	Option A	Option B
Blade Shape	☐ Flat	☐ Curved (curled with a pencil)
Blade Length	☐ Short (≤ 10 cm)	☐ Long (> 10 cm)

Justify your blade shape choice:

Why do you think this shape will help the blades turn effectively in the wind?

Justify your blade length choice:

What is your reasoning for choosing this length?

Our group's agreed design:

Blade shape: _____ Blade length: _____

We chose this combination because:



Annex 4: Building instructions

Materials checklist

Tick each item when you have confirmed it is at your station.

- ☐ 1 cylindrical cardboard tube (e.g. a Pringles can) – empty and clean, axle holes pre-punched by teacher
- ☐ 1 wooden skewer
- ☐ Card stock or stiff card
- ☐ Scissors
- ☐ Ruler
- ☐ Marker
- ☐ String (20-30 cm)
- ☐ Drinking straw
- ☐ Masking tape
- ☐ Pencil (for curling blades)
- ☐ Strong adhesive (double-sided tape recommended)
- ☐ Sand, pebbles, or marbles (for ballast)
- ☐ Small paper cup containing a 20 g load
- ☐ Fan (class-shared)



Step-by-step build

Work through each step in order. Test components as you go and make adjustments before moving on.



For visual, step-by-step instructions, you can also access the video *Simple Wind Turbine Project – Elementary Science Fair and STEM Project by STEAM Powered Family* (<https://www.youtube.com/watch?v=4m8h6SeelYw>)

#	Step	What to do
1	Check the axle holes	The holes in your cardboard tube have been pre-punched by your teacher. Check that the straw fits snugly through both holes without wobbling. If one hole is too tight, widen it gently with a pencil.
2	Thread the straw	Push the straw through both holes so it passes all the way across the inside of the cardboard tube and extends slightly on each side. The straw acts as a simple bearing, helping the axle spin freely.



3	Insert the axle and make the axle stoppers	Thread the wooden skewer through the straw. Wrap a small piece of masking tape tightly around the skewer at the front exit of the straw, and another at the back exit. Keep wrapping until each piece forms a thick bump that cannot pass into the straw. These tape stoppers prevent the axle from sliding sideways while still allowing it to rotate freely. Spin the skewer gently with one finger. It should rotate freely with no stiffness. If it feels tight, the straw may be gripping the skewer. Loosen it slightly or replace the straw before continuing.
4	Check the axle spins	Thread the skewer through the straw. Spin it gently with one finger. It should rotate freely with no stiffness. If it feels tight, the straw may be gripping the skewer – loosen it slightly or replace the straw. Fix this now before adding anything else.
5	Add ballast	Pour sand, pebbles or marbles into the bottom of the cardboard tube until it feels stable and does not tip over when the fan is running. Replace the lid or securely close the base, if needed.
6	Cut and shape the blades	Cut three blade shapes from card stock using your chosen shape and length (see Annex 3). For curved blades, place each blade on a flat surface and roll it firmly over a pencil in the same direction. All blades should curve in the same direction so the rotor remains balanced and turns efficiently.
7	Make the blade hub disc	Cut a small circle of card stock, roughly 6–8 cm in diameter. Make a small hole in the centre that fits over the skewer.
8	Attach the blades to the hub disc	Arrange your three blades evenly around the card-stock hub disc, ensuring they all face and curve in the same direction. Secure them firmly using strong double-sided tape or hot glue. Allow the adhesive to set before handling the rotor. Check from the front that the blades are evenly spaced and the rotor looks symmetrical.
9	Attach the hub disc to the skewer	Slide the completed hub disc onto the front of the skewer (the end facing the fan). Secure it with a small wrap of masking tape behind the disc so it rotates with the skewer. If available, a small amount of hot glue may also be used.
10	Optional: decorate the front	If time allows, cut a decorative circle of card stock and attach it over the front of the cardboard tube around the hub disc. This does not affect performance.
11	Attach the lifting string	Tie one end of a spare piece of string to the skewer on the back side of the turbine (the side facing away from the fan). Wrap the string in the same direction that the rotor turns two or three times so it grips. Let the string hang straight down. Tie the paper cup containing the prepared 20 g load to the free end. The cup should sit at desk level with enough room to travel upward.
12	Test by hand	Turn the skewer by hand. Does the string wind cleanly? Does the cup rise smoothly? If the string tangles or slips, re-tie it before testing with the fan.
13	Final pre-test check	Before using the fan, check that: • the rotor spins freely; • the blades are secure, evenly spaced and symmetrical; • the string winds smoothly onto the skewer without slipping; • the turbine remains stable while lifting the load.



Annex 5: Grand Challenge – Results and scientific analysis

Name:

Group:

Part A – Your test results

Run	Blade shape	Blade length	Time (seconds) / DNL (Did Not Lift)
Run 1 – Baseline			
Run 2 – Refinement			

Refinement hypothesis – complete BEFORE making your change

We changed _____ (blade shape / blade length) from _____ to _____ because we predict this will _____

Part B – Grand Challenge: Three official attempts

Attempt	Time (seconds) / DNL
Attempt 1	
Attempt 2	
Attempt 3	

Add your three times together, then divide by 3. (If your turbine did not lift the mass on an attempt, ask your teacher how to handle it before averaging.)

Our official average time: _____ seconds



Part C – Class results table

Group	Blade shape	Blade length	Run 1 (s)	Run 2 (s)	Run 3 – Grand Challenge Average (s)
1					
2					
3					
4					
5					
6					

Part D – Class graph

Create a class graph.

Using the Run 3 (Grand Challenge) average results from the class table, create a graph showing each group's performance.

- X-axis: Group number
- Y-axis: Time to lift the 20 g load (seconds)
- Give your graph a suitable title



Part E: Scientific analysis

Part 1 – Variables

Variable type	What it was in your experiment
Independent variable (what you deliberately changed between Run 1 and Run 2)	
Dependent variable (what you measured)	
Controlled variables (what you kept the same)	

Why does keeping these variables controlled matter for your results?

Part 2 –Interpreting the class data

1. Which group had the fastest average Run 3 time? Which group had the slowest? What blade shape and blade length did these groups use?

2. Look at the class graph and results table. What similarities or differences do you notice between the groups? Do any groups with similar blade shapes or blade lengths appear to have similar results? Use evidence from the graph to support your observations.



3. Our class investigation produced a relatively small dataset. Scientists usually repeat investigations many times before drawing strong conclusions. Is there a result in your class that surprised you? Suggest one possible reason for this result other than blade shape or blade length (for example, differences in construction, measurement, or testing).

Part 3 – Peer feedback

Visit one other group's turbine. Give professional engineering feedback: one strength and one suggestion, both with scientific reasoning.

Group visited: _____

One strength (with scientific reasoning)	One suggestion (with scientific reasoning)



Annex 6: Video – Inside a real wind turbine

You are visiting a real 850 kW wind turbine at a school in Ireland. Watch the video and answer the questions at each pause. Write short notes only – not full sentences.

Video moment	Question	Answer
0:21 Safety first	The guide clips a fall-arrest device onto the rope before climbing. What does this tell you about the skills and qualities needed for this job?	
2:13 The numbers	The turbine cost €1,270,000 and saves the school €120,000 per year. How many years before it paid for itself? Show your working.	
2:37 Wind too slow	The turbine is idling – not generating electricity. What is the minimum wind speed it needs to switch on? Why can't it run at any wind speed?	
5:45 The twisting problem	The nacelle rotates to face the wind – but if it spins too many times in one direction, it stops and untwists itself automatically. What do you think would happen inside the tower if it didn't?	
8:08 Tiny motor, massive job	The motor that turns the nacelle is only 2 kW. The turbine generates 850 kW. How can something so small turn something so heavy?	

After the video: How many components did you recognise from the Turbine Quiz in Lesson 1? Write every component you spotted below.

1. _____
3. _____
5. _____
7. _____
9. _____

2. _____
4. _____
6. _____
8. _____
10. _____



"Understanding wind turbine technology" is one of four learning scenarios developed as part of the adaptation of the WindEurope Teacher Toolkit for Primary Schools, carried out by European Schoolnet (EUN) in partnership with WindEurope, within the framework of the Scientix® STEM Alliance initiative.

[Learn more about the partnership and discover the other learning scenarios.](#)