

Carbon Zero Through Education

A Practical Handbook for Teachers

Erasmus+ KA210-SCH



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Carbon Zero Through Education – A Practical Handbook for Teachers

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TABLE OF CONTENTS

Foreword

Chapter 1 – About the Project

- 1.1 Welcome
- 1.2 Project Overview
- 1.3 Why “Carbon Zero Through Education”?
- 1.4 Project Objectives
- 1.5 Project Partners
- 1.6 Main Project Activities
- 1.7 Expected Results
- 1.8 How to Use This Handbook

Chapter 2 – Climate Change and Education

- 2.1 Understanding Climate Change
- 2.2 The Greenhouse Effect
- 2.3 Carbon Footprint
- 2.4 Circular Economy: Beyond Recycling
- 2.5 Renewable Energy and Sustainable Development
- 2.6 Climate Education and the School’s Role
- 2.7 Education for Sustainable Development (ESD)
- 2.8 GreenComp: The European Sustainability Competence Framework
- 2.9 Climate Education Across the Curriculum

Chapter 3 – Key Concepts

- 3.1 Climate Change
- 3.2 Carbon Footprint
- 3.3 Greenhouse Effect
- 3.4 Circular Economy
- 3.5 Recycling
- 3.6 Reusing
- 3.7 Renewable Energy
- 3.8 Sustainable Development
- 3.9 Waste Hierarchy
- 3.10 Biodiversity
- 3.11 Green Skills
- 3.12 Climate Literacy

Chapter 4 – Integrating Climate Education Across the Curriculum

- 4.1 Curriculum Integration Template
- 4.2 Subject-Based Curriculum Integration

Chapter 5 – Ready-To-Use Lesson Plans

- 5.1 Lesson Plan Index
- 5.2 Comprehensive Lesson Blueprints

Chapter 6 – Classroom Activities

- 6.1 Activity Index by Category
- 6.2 Structured Classroom Activities

Chapter 7 – Digital Tools for Climate Education

- 7.1 Digital Tools Matrix

Chapter 8 – Good Practices

- 8.1 Good Practices Framework
- 8.2 Educational Stage Models
- 8.3 Good Practices from Our Partnership
- 8.4 Transfer Between the Partner Schools
- 8.5 Student Voices: Sample Reflections

Chapter 9 – Assessment and Evaluation

- 9.1 Formative and Observational Assessment
- 9.2 Student-Centred Assessment
- 9.3 Summative and Performance Assessment
- 9.4 Measuring Impact at Project Level

Chapter 10 – School-Wide Sustainability Projects

- 10.1 Structured Event Outlines

Chapter 11 – Interactive Tools and Lesson Integration

- 11.1 Cross-Curricular Integration Paths
- 11.2 Interactive Lesson Planning Template
- 11.3 Action Plan for School-Wide Adoption

Chapter 12 – Resources and Useful Links

- 12.1 International Educational Frameworks & Platforms
- 12.2 Digital Simulations & Data Dashboards
- 12.3 Open-Source Teaching Materials & Tools
- 12.4 European Climate Policy and Country Information
- 12.5 Project Results

Glossary

References

FOREWORD

Education has always been one of the strongest forces for shaping a better future. Today, as climate change, biodiversity loss, resource depletion, and environmental challenges increasingly affect societies around the world, schools have an even greater responsibility—not only to provide knowledge but also to cultivate responsible attitudes, sustainable values, and active citizenship.

The *Carbon Zero Through Education* project was developed with the belief that meaningful climate education should become an integral part of everyday learning rather than remain limited to occasional environmental events or isolated science lessons. Through the cooperation of partner schools from Germany, Türkiye, and Italy, this Erasmus+ KA210-SCH project has created opportunities for teachers and students to learn from one another, exchange innovative practices, and work together toward a more sustainable future.

This handbook is one of the main educational outcomes of our partnership. It has been designed as a practical resource for teachers who wish to integrate sustainability into their classrooms regardless of the subjects they teach. Inside these pages, readers will find theoretical background, interdisciplinary lesson ideas, ready-to-use classroom activities, practical lesson plans, assessment suggestions, and examples that can easily be adapted to different educational contexts.

Rather than prescribing a single method of teaching, this handbook encourages flexibility, creativity, and collaboration. Every school, every classroom, and every learner is unique. We therefore hope that teachers will adapt the materials to their own curricula, local priorities, and students' needs while continuing to develop new ideas that promote environmental awareness and responsible action.

The success of this publication reflects the dedication of all partner institutions, teachers, students, and project contributors who shared their experience, expertise, and enthusiasm throughout the project. Their commitment demonstrates the true value of European cooperation, where diverse educational perspectives come together to create resources that benefit a wider community.

Climate change is one of the defining challenges of our time, but it also offers an opportunity to rethink the way we educate future generations. By helping students understand environmental issues, think critically, collaborate with others, and take informed action, teachers become powerful agents of positive change.

We sincerely hope that this handbook will inspire educators across Europe and beyond to integrate sustainability into everyday teaching, encourage innovative classroom practices, and empower young people to become responsible global citizens.

Together, through education, we can build a more sustainable future.

The Carbon Zero Through Education Project Partnership

CHAPTER 1: ABOUT THE PROJECT

1.1 Welcome

Welcome to **Carbon Zero Through Education – A Practical Handbook for Teachers**.

Climate change is no longer a distant environmental concern—it is one of the defining challenges of the twenty-first century. Rising global temperatures, biodiversity loss, increasing waste production, and unsustainable patterns of consumption affect every country and every community. Preparing younger generations to understand these challenges and act responsibly has therefore become one of the most important responsibilities of education.

Schools have a unique opportunity to inspire positive environmental action. Beyond teaching scientific facts, they help students develop critical thinking, responsible decision-making, collaboration, and active citizenship. Every classroom can become a place where sustainability is not only discussed but also experienced through meaningful learning.

The **Carbon Zero Through Education** project was created with this vision in mind. Through international cooperation between schools in Germany, Türkiye, and Italy, the project encourages teachers to integrate climate education into everyday teaching practices while helping students develop the knowledge, skills, and values needed for a more sustainable future.

This handbook is one of the main outcomes of the project. Rather than presenting only theoretical information, it offers practical guidance, ready-to-use lesson plans, classroom activities, digital resources, assessment strategies, and examples of good practice that teachers can immediately adapt to their own educational contexts.

Whether you teach science, mathematics, languages, social sciences, arts, or technology, we hope this handbook will inspire you to make sustainability an integral part of your classroom and encourage your students to become responsible global citizens.

Education has the power to change attitudes. Attitudes change behaviours. Behaviours change the future.

Welcome to our shared journey towards a more sustainable world.

1.2 Project Overview

The **Carbon Zero Through Education** project is an **Erasmus+ KA210-SCH Small-scale Partnership in School Education** that brings together three secondary schools from Germany, Türkiye, and Italy. The project is implemented over a **20-month period**, from **January 2025 to August 2026** (official project duration), with the shared objective of strengthening climate education through international cooperation and innovative teaching practices. The partner schools have known each other for around three years: their cooperation began with first contacts and joint preparation before the application and will continue beyond the end of the project.

Climate change is one of the most urgent global challenges, yet many students encounter environmental issues only through isolated lessons or occasional school events. The project

addresses this gap by promoting an interdisciplinary approach in which sustainability becomes part of everyday learning across different subjects.

Throughout the project, teachers collaborate to exchange educational practices, design innovative learning experiences, and develop classroom resources that can be used long after the project has ended. Students actively participate in workshops, collaborative projects, environmental campaigns, and international learning activities that encourage them to understand climate change while developing practical solutions for reducing their environmental impact.

The partnership also demonstrates how European cooperation can strengthen education by bringing together diverse educational experiences, cultural perspectives, and innovative teaching methodologies. By working together, partner schools create educational materials that are adaptable to different school systems and learning environments.

This handbook represents one of the project's major educational outputs and is intended to support teachers who wish to integrate sustainability into their everyday teaching regardless of subject area.

1.3 Why “Carbon Zero Through Education”?

Achieving carbon neutrality is not solely a technological or political challenge—it is also an educational one. While governments introduce environmental policies and industries invest in greener technologies, lasting change depends on informed citizens who understand the consequences of their daily choices.

Education plays a central role in building this awareness. Students who learn about climate change at an early age are more likely to develop sustainable habits, participate actively in environmental initiatives, and make responsible decisions as future consumers, professionals, and community members.

However, effective climate education goes beyond teaching scientific concepts. It encourages students to analyse real-world problems, evaluate evidence, collaborate with others, think creatively, and develop practical solutions. These competences are increasingly recognised as essential for both environmental sustainability and lifelong learning.

The Carbon Zero Through Education project therefore promotes a whole-school approach to sustainability. Instead of treating climate change as the responsibility of science teachers alone, it encourages every subject area to contribute to environmental education. Mathematics can analyse energy consumption, language lessons can develop environmental communication skills, arts can promote creative awareness campaigns, while social sciences explore environmental responsibility and sustainable citizenship.

By embedding sustainability across the curriculum, schools become powerful agents of change capable of preparing young people for the environmental challenges of the future.

1.4 Project Objectives

The project aims to support schools in integrating climate education into everyday teaching by providing practical, accessible, and innovative educational resources.

The specific objectives are to:

- increase teachers' capacity to integrate climate education across different subject areas;
- improve students' understanding of climate change, carbon footprints, renewable energy, recycling, and sustainable lifestyles;
- encourage interdisciplinary teaching through project-based and inquiry-based learning;
- promote responsible environmental behaviours both inside and outside school;
- strengthen cooperation among European schools through the exchange of innovative teaching practices;
- develop practical educational materials that remain available after the completion of the project;
- foster active citizenship, critical thinking, creativity, collaboration, and problem-solving skills through environmental education.

1.5 Project Partners

The success of the Carbon Zero Through Education project is built upon the collaboration of three schools with complementary strengths and educational experiences.

Country	Institution	Role
Germany	Gymnasium Vogelsang Solingen	Project Coordinator
Türkiye	Tavşanlı 15 Temmuz Şehitler Science High School	Project Partner
Italy	Polo Tecnico Professionale Corinaldesi Padovano, Senigallia	Project Partner

Each partner contributes specific expertise:

Germany (Gymnasium Vogelsang Solingen) serves the project as the coordinating school. It leads the overall project management, coordination and dissemination planning, hosted the first learning activity, “Climate Change in the Region”, and contributes its Year 9 project “Energy and Sustainability” and the Blue Forest reforestation initiative as good practices.

Türkiye contributes extensive experience in STEM education, project-based learning, recycling initiatives, robotics, and environmental competitions, and supported the partnership with its extensive Erasmus+ experience in application, coordination and reporting. It hosted the learning activity on renewable energy.

Italy provides expertise in technical and vocational education, environmental innovation, digital dissemination, and sustainability education supported by well-equipped laboratories and international project experience. It coordinates the eTwinning activities, through which a network of ten schools was reached, and hosted the learning activity on recycling, reuse and creative upcycling.

A shared handbook. While Gymnasium Vogelsang coordinates the project as a whole, this handbook is designed to keep the project's results alive long after its end. For this reason, it was written jointly by teachers of all three partner schools: each school contributed the chapters, lesson ideas and good practices from its own expertise. As coordinating school, Gymnasium Vogelsang edited and compiled the final version, with the agreement of all partner schools.

1.6 Main Project Activities

The project is organised around three international learning activities supported by continuous project management and dissemination.

The main thematic learning activities include:

- **Training About Climate Change** (Germany): held in Solingen from 15 to 19 September 2025 under the motto “Climate Change in the Region”
- **Renewable Energy for Ecology** (Türkiye): held in Tavşanlı from 24 to 28 November 2025, with a focus on renewable energy, climate change and carbon footprint reduction
- **Recycling and Reusage for Ecology** (Italy): held in Senigallia from 13 to 17 April 2026 as the final learning activity of the project; instead of the originally planned visit to a recycling centre, participants visited a local sustainability club
- Continuous dissemination and awareness-raising activities
- Development of educational resources and classroom materials

Throughout these activities, teachers exchange good practices while students participate in collaborative workshops, experiments, environmental campaigns, and interdisciplinary learning experiences.

Inclusion: The student bodies of all three partner schools are very diverse in social, cultural and economic terms. Because the mobilities were fully funded by Erasmus+, participation did not depend on family income or background: participants were selected on the basis of their interest and commitment.

1.7 Expected Results

The project aims to create lasting educational impact beyond the project duration.

The main expected results include:

- increased climate literacy among students;
- improved teacher confidence in teaching sustainability topics;
- interdisciplinary lesson plans and classroom activities;
- practical tools for integrating environmental education into different subjects;
- stronger international cooperation between partner schools;
- greater student engagement in sustainable behaviours;

- a transferable teacher handbook that can be used by educators across Europe.

1.8 How to Use This Handbook

This handbook has been designed as a flexible resource rather than a traditional textbook.

Teachers may choose to use complete lesson plans or adapt individual activities to suit their own curriculum, students' ages, available resources, and local educational requirements.

The handbook is organised into thematic chapters that combine theoretical background with practical classroom applications. Readers will find subject-specific lesson ideas, ready-to-use activities, digital tools, examples of good practice, assessment strategies, and additional resources that support climate education in diverse educational contexts.

The activities may be implemented independently, integrated into existing curricula, or combined to develop interdisciplinary projects. Many of the suggested tasks encourage collaboration, inquiry-based learning, creativity, and active student participation.

Chapter 8.3 is dedicated to the good practices our three schools developed and exchanged during the project, from the Year 9 project "Energy and Sustainability" in Solingen to the annual Plogging Day inspired by our Italian partners. These examples show how ideas travel between schools and can be adapted to different regional needs and budgets.

Although developed within an Erasmus+ partnership, the handbook is intended for teachers everywhere who wish to create more sustainable schools and empower young people to contribute to a greener future.

CHAPTER 2: CLIMATE CHANGE AND EDUCATION

“Education is one of the most powerful tools for addressing climate change—not because it changes the climate directly, but because it changes people.”

Chapter Overview

Climate change is one of the defining challenges of the twenty-first century. Rising temperatures, biodiversity loss, resource depletion, pollution, and extreme weather events are affecting ecosystems, economies, and societies worldwide. These environmental changes influence every aspect of human life, including health, agriculture, water resources, energy production, and education.

Although governments, scientists, industries, and international organisations play essential roles in addressing climate change, sustainable solutions also depend on informed and responsible citizens. Education therefore becomes a key driver of environmental awareness and long-term behavioural change.

This chapter introduces the scientific foundations of climate change together with the educational approaches that help teachers integrate sustainability into everyday learning. It also explains the European policy framework supporting climate education and highlights the importance of developing green competences among students.

2.1 Understanding Climate Change

Climate change refers to long-term changes in the Earth’s climate system, including average temperatures, precipitation patterns, sea levels, and the frequency of extreme weather events. Although the Earth’s climate has naturally changed throughout history, scientific evidence shows that current changes are occurring much faster than natural climate cycles due to human activities.

The primary driver of modern climate change is the increased concentration of greenhouse gases in the atmosphere. These gases trap heat that would otherwise escape into space, resulting in a gradual increase in global temperatures. Human activities such as burning fossil fuels, deforestation, industrial production, intensive agriculture, and unsustainable consumption have significantly accelerated this process.

The consequences of climate change are already visible around the world. They include more frequent heatwaves, prolonged droughts, stronger storms, melting glaciers, rising sea levels, biodiversity loss, food insecurity, and increasing risks to human health. These impacts affect communities differently, making climate change not only an environmental issue but also a social, economic, and ethical challenge.

For educators, understanding climate change is essential because today’s students will make many of the decisions that shape tomorrow’s environmental future. Schools therefore have an important role in helping young people understand both the causes of climate change and the actions needed to mitigate its effects.

2.2 The Greenhouse Effect

The greenhouse effect is a natural process that keeps the Earth warm enough to support life. Solar radiation reaches the Earth's surface, where part of the energy is absorbed and later released as infrared radiation. Greenhouse gases—including carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and water vapour—trap some of this outgoing heat, maintaining a stable global temperature.

Human activities have intensified this natural process by increasing greenhouse gas concentrations. Since the Industrial Revolution, the widespread use of coal, oil, and natural gas has significantly increased atmospheric carbon dioxide levels. As a result, more heat is retained within the Earth's atmosphere, leading to global warming and associated climate changes.

Understanding the greenhouse effect helps students distinguish between a natural phenomenon that supports life and the enhanced greenhouse effect caused by human activities.

2.3 Carbon Footprint

A carbon footprint measures the total amount of greenhouse gases generated directly and indirectly by an individual, organisation, product, or activity. It is commonly expressed as carbon dioxide equivalent (CO₂e), allowing different greenhouse gases to be compared using a common unit.

Everyday activities contribute to our carbon footprint. Electricity consumption, transportation, food choices, shopping habits, waste generation, and heating systems all produce greenhouse gas emissions. While individual actions alone cannot solve climate change, collective behavioural changes supported by effective public policies can significantly reduce overall emissions.

For students, calculating personal or school carbon footprints provides a practical way to understand how daily decisions influence the environment. Classroom investigations into energy use, transportation, food waste, or recycling encourage learners to connect scientific concepts with their own experiences.

2.4 Circular Economy: Beyond Recycling

Many people associate sustainability primarily with recycling. Although recycling is important, it represents only one element of a broader circular economy.

A circular economy aims to keep products, materials, and resources in use for as long as possible. Rather than following the traditional “take–make–dispose” model, circular systems encourage reducing consumption, reusing materials, repairing products, refurbishing equipment, and recycling materials when reuse is no longer possible.

Schools provide excellent opportunities to introduce circular economy principles through practical activities such as repair workshops, upcycling projects, clothing exchanges, creative reuse of classroom materials, and waste audits. These experiences help students recognise waste as a resource and encourage more sustainable patterns of consumption.

2.5 Renewable Energy and Sustainable Development

Renewable energy refers to energy obtained from naturally replenishing sources such as sunlight, wind, flowing water, geothermal heat, and biomass. Unlike fossil fuels, renewable energy sources produce significantly lower greenhouse gas emissions during operation and contribute to reducing climate change.

Introducing renewable energy concepts at school helps students understand both technological innovation and environmental responsibility. Practical investigations—such as building simple solar-powered devices or measuring energy consumption—encourage inquiry-based learning while demonstrating real-world applications of science and engineering.

Renewable energy is also closely connected with sustainable development because it supports cleaner air, improved public health, energy security, and economic innovation.

2.6 Climate Education and the School's Role

Climate education is far more than teaching environmental science. It develops the knowledge, skills, values, and attitudes necessary for responsible decision-making in an increasingly complex world.

Effective climate education encourages students to:

- understand scientific evidence;
- evaluate information critically;
- recognise misinformation;
- collaborate to solve problems;
- consider different perspectives;
- make informed decisions;
- participate actively in their communities.

Schools influence students not only through lessons but also through everyday practices. Energy-efficient buildings, recycling systems, sustainable procurement, school gardens, active transportation initiatives, and student environmental clubs all contribute to creating a culture of sustainability.

When sustainability becomes part of the entire school culture, students learn through experience as well as instruction.

2.7 Education for Sustainable Development (ESD)

Education for Sustainable Development (ESD) is an educational approach that empowers learners to make informed decisions and take responsible actions for environmental integrity, economic viability, and social justice.

Rather than adding another subject to the curriculum, ESD encourages sustainability to be integrated across all disciplines. Mathematics lessons may analyse environmental data,

language classes may examine persuasive communication about climate issues, while arts education can inspire environmental creativity.

ESD promotes interdisciplinary learning, critical thinking, collaboration, creativity, systems thinking, and responsible citizenship—all competences essential for addressing sustainability challenges.

2.8 GreenComp: The European Sustainability Competence Framework

To support sustainability education across Europe, the European Commission developed **GreenComp**, the European Sustainability Competence Framework.

GreenComp identifies four interconnected competence areas:

Embodying Sustainability Values

Learners develop respect for nature, responsibility, fairness, and future-oriented thinking.

Embracing Complexity in Sustainability

Students learn systems thinking, critical analysis, and the ability to understand relationships between environmental, social, and economic issues.

Envisioning Sustainable Futures

Learners imagine alternative futures, evaluate different scenarios, and design innovative solutions.

Acting for Sustainability

Students become active participants in environmental improvement through collaboration, problem-solving, and civic engagement.

These competences complement existing curricula and can be developed across every subject area.

2.9 Climate Education Across the Curriculum

Climate education should not be limited to science lessons.

Every subject contributes differently:

Subject	Possible Contribution
Mathematics	Analyse climate statistics and carbon data
Science	Investigate ecosystems and renewable energy; evaluate energy sources (e.g., in an interdisciplinary project on energy and sustainability)
Geography	Study climate zones and environmental change; plan regional reforestation
History	Examine industrialisation and environmental impacts
Foreign Languages (e.g., French, English)	Compare how other countries deal with climate change, recycling and renewable energy; debate and develop persuasive writing

Subject	Possible Contribution
Languages of Schooling (German, Italian, Turkish)	Analyse contemporary newspaper articles and literary works on climate and the environment
Arts	Create awareness campaigns, murals, recycled artworks and furniture made from waste
ICT	Develop digital sustainability projects
Physical Education	Promote sustainable lifestyles, active transport and plogging

This interdisciplinary approach reflects the philosophy of the Carbon Zero Through Education project and demonstrates that every teacher can contribute to environmental literacy.

Chapter Summary

Climate change is a complex global challenge requiring informed, collaborative, and responsible action. Education equips young people with the knowledge, values, and competences needed to address this challenge. By integrating sustainability across subjects, adopting whole-school approaches, and developing GreenComp competences, teachers help prepare students not only to understand climate change but also to become active contributors to a more sustainable future.

Reflection Questions

1. How is climate change currently addressed in your school?
2. Which subjects already include sustainability-related topics?
3. What opportunities exist for interdisciplinary collaboration among teachers?
4. How can your classroom model sustainable practices?
5. Which GreenComp competences do your current lessons already support?

CHAPTER 3: KEY CONCEPTS

This chapter establishes a clear, unified conceptual framework for the entire handbook. Rather than presenting isolated definitions, each section is structured as a dedicated reference page for educators, connecting scientific parameters with pedagogical strategy, real-world examples, and classroom reflection.

3.1 Climate Change

- **Core Definition:** Long-term, significant shifts in global or regional climate patterns—including averages and variability in temperature, precipitation, and wind structures—primarily driven by human activities since the mid-19th century.
- **Pedagogical Approach:** Distinguish clearly between *weather* (short-term atmospheric conditions) and *climate* (long-term historical trends observed over 30 or more years). Use the analogy of an individual’s daily mood versus their overall character traits.
- **Real-World Connection:** Accelerated warming trends, changing agricultural planting timelines, shifting ecological boundaries, and the rising frequency of severe weather events globally.
- **Reflection Prompt:** How can we guide students to see that “global warming” does not just mean hotter days, but a fundamental destabilisation of planetary systems?

3.2 Carbon Footprint

- **Core Definition:** The total volume of greenhouse gases, primarily carbon dioxide (CO₂) and methane (CH₄), emitted directly or indirectly by an individual, organisation, event, process, or product, measured in carbon dioxide equivalents (CO₂e).
- **Pedagogical Approach:** Describe it as an invisible tracking ledger left behind by daily lifestyle choices, consumer patterns, and production mechanisms. Every physical object or unit of energy carries a hidden emission footprint.
- **Real-World Connection:** School transportation modes, classroom lighting systems, digital server usage, and the lifecycle supply chains of school lunches or imported teaching materials.
- **Reflection Prompt:** In what ways can calculating a classroom’s collective footprint transform abstract statistical data into personal environmental responsibility?

3.3 Greenhouse Effect

- **Core Definition:** The natural process where specific atmospheric gases trap thermal infrared radiation emitted from the Earth’s surface, preventing it from escaping directly into space and thereby maintaining global temperatures suitable for life.
- **Pedagogical Approach:** Use the classic analogy of a glass greenhouse or a car parked in direct sunlight with the windows up. Differentiate carefully between the *natural* greenhouse effect that permits life and the *enhanced* greenhouse effect driven by human pollution.

- **Real-World Connection:** The historical stability of Earth's biosphere relying on balanced gas concentrations, contrasted with the rapid modern increase in atmospheric CO₂ from burning fossil fuels.
- **Reflection Prompt:** How can teachers clarify to students that greenhouse gases are not inherently malicious, but rather an equilibrium that humanity has disrupted?

3.4 Circular Economy

- **Core Definition:** An industrial and economic model designed to eliminate waste through the continuous cycle of recovery, restoration, repair, and regeneration of materials and products, replacing the traditional linear "take-make-dispose" paradigm.
- **Pedagogical Approach:** Contrast the structural vulnerability of a straight line (extracting resources, manufacturing a product, discarding it to a landfill) with the infinite loop of a circle, mimicking natural ecological decomposition where waste does not exist.
- **Real-World Connection:** Manufacturing modular electronics with easily swappable, repairable parts, or implementing institutional procurement systems that prioritise long-lasting, returnable packaging over single-use items.
- **Reflection Prompt:** What barriers prevent our current consumer society from transitioning from a linear mindset to a truly circular system?

3.5 Recycling

- **Core Definition:** The industrial process of collecting, sorting, processing, and breaking down waste materials into raw secondary inputs to manufacture entirely new products, thereby reducing the extraction of virgin resources.
- **Pedagogical Approach:** Emphasise that recycling is an energy-intensive industrial mechanism. It should not be taught as the primary solution to waste, but rather as a necessary restorative step when reduction and reuse are no longer viable.
- **Real-World Connection:** Segregated sorting systems for aluminium, paper, and specialised plastics within school buildings, leading to the industrial transformation of post-consumer waste into structural materials.
- **Reflection Prompt:** How can we educate our school community to recognise that sorting waste correctly is only effective if a viable recycling market and processing infrastructure exist?

3.6 Reusing

- **Core Definition:** The practice of using an item again for its original purpose or repurposing it for a new structural function without subjecting it to industrial degradation or chemical reprocessing.
- **Pedagogical Approach:** Position reuse significantly higher than recycling on the waste management hierarchy. Highlight that reuse extends an object's lifespan immediately while bypassing the carbon-heavy energy requirements of industrial manufacturing plants.

- **Real-World Connection:** Transitioning from disposable cups to durable glass jars or stainless steel bottles, exchanging textbooks across grade levels, and utilising upcycled storage bins within the classroom.
- **Reflection Prompt:** What creative institutional changes can our school implement to ensure items are reused multiple times before entering the waste stream?

3.7 Renewable Energy

- **Core Definition:** Energy derived from natural, self-replenishing sources that regenerate through biogeochemical processes at a rate equal to or faster than their human consumption.
- **Pedagogical Approach:** Compare finite resource reserves (such as coal or oil deposits that take millions of years to form) with continuous planetary forces (sunlight, wind currents, tidal movements, and geothermal heat gradients).
- **Real-World Connection:** The installation of photovoltaic arrays on public infrastructure, localised wind turbine networks, and the integration of smart grids to power educational environments cleanly.
- **Reflection Prompt:** Beyond reducing emissions, how does transitioning to localised renewable energy increase a community's economic resilience and energy security?

3.8 Sustainable Development

- **Core Definition:** Socioeconomic and infrastructural development that effectively meets the urgent needs of the present generation without compromising or depleting the environmental capacity of future generations to meet their own needs.
- **Pedagogical Approach:** Utilise the framework of a balanced tripod or scale consisting of three core pillars: Environmental Protection, Social Equity, and Economic Viability. If any single pillar is neglected, the entire developmental structure collapses.
- **Real-World Connection:** Urban planning projects that integrate accessible public transit, zero-emission building codes, public green spaces, and localised food production systems.
- **Reflection Prompt:** How can we teach students to critically evaluate whether a modern technological innovation or business model is genuinely sustainable or merely short-sighted?

3.9 Waste Hierarchy

- **Core Definition:** A structured prioritisation framework for sustainable waste management, ordering strategies by environmental preference: Prevention, Reduction, Reuse, Recycling, Recovery, and Disposal.
- **Pedagogical Approach:** Illustrate this concept visually as an inverted pyramid. The broadest tier at the top represents absolute waste avoidance, while the narrowest point at the bottom represents the ultimate systemic failure: the landfill.

- **Real-World Connection:** A school campus implementing zero-plastic policies (Prevention), minimising paper use through digital tools (Reduction), repairing broken furniture (Reuse), and composting organic food leftovers (Recovery).
- **Reflection Prompt:** Why does modern culture over-emphasise recycling while frequently ignoring the far more impactful strategies of prevention and reduction?

3.10 Biodiversity

- **Core Definition:** The structural variety, genetic variability, and complex interdependence of all living organisms across genetic, species, and ecosystem levels within a given biosphere.
- **Pedagogical Approach:** Analogise an ecosystem to a highly intricate, interconnected web or a structural Jenga tower. The systematic removal of seemingly minor species degrades the integrity of the entire web, threatening systemic collapse.
- **Real-World Connection:** The vital role of local insect pollinators in agricultural yields, the purification of water tables by complex wetland root networks, and forest ecosystems acting as primary carbon sinks.
- **Reflection Prompt:** In what ways does rapid climate change accelerate the loss of regional biodiversity, and what are the direct consequences for human survival?

3.11 Green Skills

- **Core Definition:** The technical knowledge, practical expertise, core values, capabilities, and behavioural attitudes required by individuals to build, maintain, and manage a resource-efficient, low-carbon, and sustainable society.
- **Pedagogical Approach:** Demystify the concept by demonstrating that green skills are not exclusive to ecological scientists. They span across vocations, including sustainable architectural design, energy-efficient coding, eco-literate financial planning, and environmental impact auditing.
- **Real-World Connection:** Vocational training programmes focused on solar photovoltaic maintenance, automated building management systems, and agricultural water-conservation technologies.
- **Reflection Prompt:** How can we adapt our traditional school curricula to ensure that every graduate possesses the foundational green skills demanded by the future economy?

3.12 Climate Literacy

- **Core Definition:** An individual's comprehensive understanding of the Earth's climate system, the profound impacts of anthropogenic activities on global climate dynamics, and the capacity to apply this knowledge to make scientifically sound decisions.
- **Pedagogical Approach:** Frame a climate-literate citizen as someone capable of analysing scientific consensus, identifying corporate greenwashing, rejecting environmental misinformation, and acting as an advocate for systemic sustainability.

- **Real-World Connection:** Students critically vetting media reports using primary peer-reviewed scientific journals, analysing local energy policies, and initiating verified awareness campaigns in their home communities.
- **Reflection Prompt:** How does achieving widespread climate literacy among youth alter the long-term socio-political trajectory of environmental policy?

CHAPTER 4: INTEGRATING CLIMATE EDUCATION ACROSS THE CURRICULUM

This chapter provides an operational blueprint for integrating climate change and sustainability into nineteen academic disciplines. Rather than isolating ecological themes within science classes, this framework uses an interdisciplinary methodology aligned with the European Sustainability Competence Framework (*GreenComp*). Each discipline follows a standard curriculum template to ensure consistency, rigor, and ease of delivery for educators.

4.1 Curriculum Integration Template

To maintain instructional continuity across all grade levels and subjects, every discipline in this chapter is structured around the following nine core criteria:

1. **Connection:** Explains the conceptual link between the specific subject matter and climate/sustainability education.
2. **Learning Outcomes:** Specifies what students will know, understand, and be able to do upon completion of the unit.
3. **Skills:** Highlights cognitive, practical, and systemic skills developed through the lessons.
4. **GreenComp Areas:** Explicitly maps the activities to the four main domains of the European Sustainability Competence Framework.
5. **Materials:** Details physical, digital, and environmental resources required for execution.
6. **Lesson Flow:** Outlines a structured pedagogical sequence (Warm-up, Main Activities, and Wrap-up).
7. **Assessment:** Provides methods to evaluate student mastery of both subject content and sustainability concepts.
8. **Extension:** Suggests advanced or out-of-classroom activities to deepen engagement.
9. **Reflection:** Offers metacognitive prompts for teachers and students to evaluate the broader impact of the learning experience.

Where a subject was put into practice during the Carbon Zero Through Education project, an additional **Project Link** shows how the partner schools implemented it. Further details are given in Chapter 8.3.

4.2 Subject-Based Curriculum Integration

1. Mathematics

- **Connection:** Using quantitative analysis, statistical modelling, and data visualisation to interpret global temperature anomalies, carbon emission trends, and resource depletion rates.

- **Learning Outcomes:** Students will calculate percentage increases in atmospheric carbon concentrations and construct linear models forecasting future resource degradation based on current consumption metrics.
- **Skills:** Statistical data analysis, algebraic modelling, computational logic, and graphic interpretation.
- **GreenComp:** *Embracing complexity in sustainability* (Systems thinking, critical thinking).
- **Materials:** Global carbon emissions dataset spreadsheets, graphing calculators, and climate data access portals.
- **Lesson Flow:**
 - *Warm-up:* Analyse a single graph showing global temperature changes over the past 150 years.
 - *Main Activities:* Students use real-world datasets to calculate individual and institutional carbon footprints, converting raw energy use into CO₂ equivalents.
 - *Wrap-up:* Compare calculated footprints and identify mathematical outliers.
- **Assessment:** Evaluation of student-constructed climate trend models and the accuracy of their mathematical interpretations.
- **Extension:** Collaborate with school administration to run a long-term statistical audit of the school building's monthly water and electricity billing.
- **Reflection:** How do abstract mathematical figures help us grasp the tangible scale of ecological challenges?

2. Physics

- **Connection:** Analysing thermodynamics, electromagnetic radiation, and energy transfer mechanisms to understand the physical mechanics of the greenhouse effect and renewable energy generation.
- **Learning Outcomes:** Students will explain how greenhouse gases absorb and re-emit infrared radiation, and evaluate the conversion efficiency of photovoltaic solar cells.
- **Skills:** Thermodynamic calculation, experimental data collection, variable isolation, and systematic laboratory design.
- **GreenComp:** *Envisioning sustainable futures* (Exploratory thinking, adaptability).
- **Materials:** Infrared thermometers, small solar photovoltaic panels, multimeters, and glass containers for greenhouse models.
- **Lesson Flow:**
 - *Warm-up:* Demonstrate heat retention differences in sealed vs. open containers under a heat lamp.

- *Main Activities:* Measure the electrical current and voltage output of a mini solar panel at varying angles of incidence to determine peak operational efficiency.
- *Wrap-up:* Discuss how cloud cover and atmospheric dust change solar energy output.
- **Assessment:** Technical laboratory report detailing the physical equations governing heat retention and energy conversions.
- **Extension:** Construct a prototype solar-powered phone charger using recycled electronic parts.
- **Reflection:** How can understanding the laws of physics help us design more efficient mitigation technologies?
- **Cross-Curricular Link (PE):** After the annual Plogging Day (see Physical Education and Lesson Plan 11), students calculate how much energy the runners used and compare it with the output of a wind turbine and the annual electricity demand of a household.
- **Project Link:** Gymnasium Vogelsang’s Year 9 project “Energy and Sustainability” with its Lab Day (Chapter 8.3) and the visits to a biogas plant, geothermal plants and solar-powered ceramics factories in and around Tavşanlı.

3. Chemistry

- **Connection:** Investigating atmospheric chemical compositions, fossil fuel combustion reactions, ocean acidification mechanics, and the molecular lifecycles of polymers.
- **Learning Outcomes:** Students will balance chemical equations for hydrocarbon combustion and write out the chemical reactions that form carbonic acid from dissolved atmospheric carbon dioxide.
- **Skills:** Chemical equation balancing, pH laboratory testing, molecular lifecycle analysis, and laboratory safety protocols.
- **GreenComp:** *Embracing complexity in sustainability* (Problem formulation, interdisciplinary analysis).
- **Materials:** pH indicators, distilled water, stopwatches, straws (for breathing CO₂ into water samples), and molecular modelling kits.
- **Lesson Flow:**
 - *Warm-up:* Introduce the chemical formula of atmospheric greenhouse gases.
 - *Main Activities:* Bubble exhaled breath (CO₂) into water samples containing pH indicators to model the process of ocean acidification.
 - *Wrap-up:* Connect laboratory pH drops to the destruction of marine ecosystems.
- **Assessment:** Practical exam testing student understanding of combustion reactions and ocean acidification pathways.

- **Extension:** Analyse the chemical differences between petroleum-based polymers and bioplastics made from organic starches.
- **Reflection:** How can green chemistry help us develop materials that don't persist in ecosystems for centuries?
- **Project Link:** In Senigallia, chemistry lab students calculated the energy needed to produce a pair of jeans, an eye-opening way to reveal the hidden footprint of everyday clothing.

4. Biology

- **Connection:** Examining how changing climate baselines alter ecosystems, compromise regional biodiversity, disrupt food webs, and shift species distributions.
- **Learning Outcomes:** Students will map the direct impacts of temperature increases on localised ecosystems and analyse how habitat fragmentation compromises genetic diversity.
- **Skills:** Ecological mapping, food web analysis, field sampling techniques, and taxonomic identification.
- **GreenComp:** *Embodying sustainability values* (Respecting nature, ecological stewardship).
- **Materials:** Ecosystem mapping software, quadrat sampling frames for field study, and regional biodiversity field guides.
- **Lesson Flow:**
 - *Warm-up:* Examine how a single invasive species can destabilise a balanced local food chain.
 - *Main Activities:* Conduct a quadrat field survey on school grounds to log insect and plant diversity, identifying species vulnerable to shifting microclimates.
 - *Wrap-up:* Synthesise group field data into a unified biodiversity map.
- **Assessment:** Student-designed ecological management plan focused on protecting regional biodiversity from rising temperatures.
- **Extension:** Design and install a native wildflower pollinator zone on the school grounds to boost local insect populations.
- **Reflection:** What responsibility do humans carry to protect non-human species from anthropogenic climate impacts?
- **Project Link:** The Blue Forest in Solingen-Gräfrath (Chapter 8.3): students explore which native tree species are resilient to a changing climate and plan a reforestation adapted to their own region.

5. Geography

- **Connection:** Analysing climate zones, changing weather trends, resource distribution patterns, and the human geographies of climate-induced migration.

- **Learning Outcomes:** Students will utilise Geographic Information Systems (GIS) to track global deforestation patterns and map areas vulnerable to rising sea levels.
- **Skills:** Cartographic literacy, GIS data mapping, spatial pattern analysis, and demographic forecasting.
- **GreenComp:** *Embracing complexity in sustainability* (Systems thinking, spatial orientation).
- **Materials:** Digital access to open-source GIS platforms (e.g., Google Earth Engine), physical world maps, and regional climate maps.
- **Lesson Flow:**
 - *Warm-up:* Compare satellite images of an area (like the Aral Sea or Amazon rainforest) over a thirty-year timeframe.
 - *Main Activities:* Map global coastal population centres against 1-metre and 2-metre sea-level rise projections to identify future climate migration routes.
 - *Wrap-up:* Discuss the geopolitical implications of large-scale environmental displacement.
- **Assessment:** A detailed GIS mapping project analysing the socioeconomic vulnerabilities of a chosen region to climate impacts.
- **Extension:** Develop a localised flood risk or drought vulnerability map for the school's immediate municipality.
- **Reflection:** How do global geographical imbalances shape who suffers the most from carbon emissions?
- **Project Link:** During the learning activity in Solingen, students visited the Garzweiler lignite mine, the Station Natur und Umwelt and the Schwebodrom in Wuppertal, and learnt from representatives of the City of Solingen how the city adapts to climate change since the flood of July 2021, for example by creating more open space for drainage. Combined with the Blue Forest reforestation (Chapter 8.3), this shows how global climate issues become visible in one's own region.

6. History

- **Connection:** Tracing the environmental history of human societies, from agrarian resource use to the Industrial Revolution and the modern carbon-intensive global economy.
- **Learning Outcomes:** Students will analyse historical primary documents to trace how the adoption of coal and oil engines reshaped global trade, demographics, and atmospheric profiles.
- **Skills:** Primary document analysis, chronological reasoning, causal historical mapping, and historical perspective-taking.
- **GreenComp:** *Embracing complexity in sustainability* (Critical thinking, historical contextualisation).

- **Materials:** 19th-century industrial factory records, historical atmospheric carbon core data graphs, and excerpts from early environmental literature.
- **Lesson Flow:**
 - *Warm-up:* Examine a timeline showing when major fossil fuels were introduced into global manufacturing.
 - *Main Activities:* Read primary testimonies from the early Industrial Revolution in Europe, analysing how societal perceptions of progress ignored environmental footprints.
 - *Wrap-up:* Connect historical resource choices with current environmental impacts.
- **Assessment:** Analytical essay evaluating the relationship between industrialisation, colonisation, and the modern climate challenge.
- **Extension:** Research and compile an environmental history timeline of the school's local industrial region.
- **Reflection:** How can understanding past environmental policy mistakes guide our current transition to net-zero models?

7. English

- **Connection:** Developing critical communication, persuasive writing, media analysis, and rhetorical skills through studying climate journalism and environmental literature.
- **Learning Outcomes:** Students will differentiate between evidence-based environmental reporting and corporate greenwashing in public media campaigns.
- **Skills:** Rhetorical analysis, persuasive writing, public speaking, and media literacy.
- **GreenComp:** *Acting for sustainability* (Political agency, collective action).
- **Materials:** Current news articles, advertisements containing environmental claims, and public speech transcripts from climate summits.
- **Lesson Flow:**
 - *Warm-up:* Define “greenwashing” using examples from consumer product advertising.
 - *Main Activities:* Deconstruct environmental speeches, identifying rhetorical appeals (ethos, pathos, logos) used to persuade audiences to take environmental action.
 - *Wrap-up:* Present a 1-minute summary analysing the accuracy of a media article's climate claims.
- **Assessment:** A well-researched, persuasive essay or delivered speech targeting a specific local environmental issue.
- **Extension:** Create a student-run digital environmental newsletter or podcast highlighting sustainability work within the school.

- **Reflection:** How can we use language effectively to inspire collective action without causing climate anxiety?

8. Turkish

- **Connection:** Exploring environmental ethics, nature writing, and sustainable community values through Turkish literary works, poetry, and classical text analysis.
- **Learning Outcomes:** Students will analyse how nature is represented in classical and modern Turkish literature, identifying changing cultural relationships with the environment.
- **Skills:** Textual critique, literary analysis, creative writing, and linguistic precision.
- **GreenComp:** *Embodying sustainability values* (Cultural perspective, environmental equity).
- **Materials:** Selected poems (e.g., Aşık Veysel's "Kara Toprak"), short stories, and environmental essays by Turkish authors.
- **Lesson Flow:**
 - *Warm-up:* Listen to and discuss the ecological philosophy embedded in traditional folk music or poetry.
 - *Main Activities:* Deconstruct selected literary works to analyse how the relationship between human well-being and land health is portrayed.
 - *Wrap-up:* Share student poetry focused on current local ecological transformations.
- **Assessment:** Analytical essay or creative writing portfolio assessing the text's eco-literary value and cultural relevance.
- **Extension:** Collect and publish a digital anthology of student-written environmental short stories in Turkish.
- **Reflection:** How does our mother tongue shape our deep emotional connection to the physical landscapes we inhabit?

9. ICT (Information and Communication Technology)

- **Connection:** Evaluating the hidden carbon footprint of digital infrastructure, global server systems, and electronics production, while using technology to model environmental solutions.
- **Learning Outcomes:** Students will compute the electronic waste (e-waste) impact of consumer tech lifecycles and build functional databases to track school-wide resource metrics.
- **Skills:** Data management, system auditing, digital carbon accounting, and software architecture.
- **GreenComp:** *Acting for sustainability* (Using digital tools for systemic interventions).
- **Materials:** Digital carbon footprint estimation tools, spreadsheet software, and hardware lifecycle analysis databases.

- **Lesson Flow:**
 - *Warm-up:* Calculate the carbon emissions generated by sending thousands of unread emails or streaming video files.
 - *Main Activities:* Build a functional, automated spreadsheet tracking dashboard to monitor the school's paper use across different departments.
 - *Wrap-up:* Share dashboard findings and propose digital mitigation strategies.
- **Assessment:** Functional database or tracking application developed to streamline institutional sustainability logging.
- **Extension:** Run a school-wide hardware donation and modular repair campaign to reduce hazardous electronic waste.
- **Reflection:** How can we balance the benefits of digital transformation with the heavy carbon footprint of physical data hubs?

10. Computer Science

- **Connection:** Writing efficient, green code to minimise processor power use and engineering algorithms to optimise resource distribution networks.
- **Learning Outcomes:** Students will write algorithmic code that optimises power load distribution for a mock smart grid or public transport route.
- **Skills:** Algorithmic efficiency analysis, logic programming, data structures, and systemic simulation design.
- **GreenComp:** *Envisioning sustainable futures* (Systemic design, technological innovation).
- **Materials:** Python or block-based programming environments, sensor kits (micro:bits), and automation simulation software.
- **Lesson Flow:**
 - *Warm-up:* Discuss how inefficient software programming increases electricity use in global server farms.
 - *Main Activities:* Write an optimisation algorithm that schedules automated school lighting and climate systems based on room occupancy data.
 - *Wrap-up:* Run code tests and compare the simulated energy savings of different student algorithms.
- **Assessment:** Evaluation of student code efficiency, logic, and its practical ability to reduce simulated energy use.
- **Extension:** Use programmable microcontrollers and moisture sensors to build an automated water-saving irrigation system for the school garden.
- **Reflection:** How can algorithmic optimisation prevent resource waste at a global scale?

- **Project Link:** The cycling reward app inspired by our Turkish partner school (see 13. Physical Education) offers a real development task for computer science classes: tracking distances, calculating CO₂ savings and designing a fair reward system with data protection in mind.

11. Visual Arts

- **Connection:** Using upcycled materials for artistic expression and designing visual media campaigns that challenge unsustainable consumption habits.
- **Learning Outcomes:** Students will create conceptual sculptures using non-recyclable materials and design infographics that convey complex climate science.
- **Skills:** Material upcycling, graphic design layout, composition, and visual communication.
- **GreenComp:** *Envisioning sustainable futures* (Creative problem solving, cultural expression).
- **Materials:** Discarded single-use plastics, scrap cardboard, non-toxic water-based mediums, and graphic layout applications.
- **Lesson Flow:**
 - *Warm-up:* Review famous examples of environmental activism art and eco-sculptures.
 - *Main Activities:* Transform clean, non-recyclable institutional waste into a collaborative public sculpture that illustrates plastic persistence.
 - *Wrap-up:* Curate the artwork in the school's central hallway with student-written artist statements.
- **Assessment:** Rubric evaluating the technical skill, creative material choice, and environmental message of the art piece.
- **Extension:** Organise a community-wide upcycled art exhibition to raise public awareness about the circular economy.
- **Reflection:** How can art engage people's emotions on environmental issues in ways that scientific data alone cannot?
- **Furniture from Waste:** Inspired by our Italian partner school in Senigallia, students design and build functional furniture from collected and recycled waste materials, such as benches from pallets, stools from tyres or shelves from crates. The pieces can furnish classrooms, the schoolyard or a "recycled furniture store" exhibition, and connect art with technology and the circular economy (see Chapter 10, Project 10).
- **Project Link:** In Senigallia, students from three countries painted a large mural with messages of peace in languages from all continents on the sports hall of the partner school, together with a local group of artists. The fashion class also presented outfits made from upcycled materials.

12. Music

- **Connection:** Exploring acoustic ecology, translating environmental datasets into musical compositions (sonification), and creating soundscapes that document environmental change.
- **Learning Outcomes:** Students will compose short acoustic or digital scores that map local environmental data points to musical elements like pitch and tempo.
- **Skills:** Auditory composition, digital audio editing, acoustic analysis, and creative symbolic translation.
- **GreenComp:** *Embodying sustainability values* (Aesthetic appreciation, ecological empathy).
- **Materials:** Digital audio workstations (DAWs), field audio recorders, and historical climate dataset profiles.
- **Lesson Flow:**
 - *Warm-up:* Listen to soundscapes from healthy versus ecologically degraded forest environments.
 - *Main Activities:* Map global temperature data over time to musical scales, translating rising carbon trends into shifts in pitch and tempo.
 - *Wrap-up:* Perform and record student climate sonification pieces.
- **Assessment:** Evaluation of the student's completed sound composition and their written explanation of how it maps to climate datasets.
- **Extension:** Record an acoustic sound map documenting noise pollution and biodiversity indicators around the school community.
- **Reflection:** How does transforming data from a visual graph into a musical score change how we connect with environmental issues?
- **Project Link:** In Senigallia, students and teachers sang songs together in Italian, Turkish and German. Music is an easy way to build community across languages.

13. Physical Education (PE)

- **Connection:** Promoting carbon-neutral active transport, outdoor environmental stewardship through plogging, and understanding how air quality affects physical health.
- **Learning Outcomes:** Students will calculate the personal health benefits and carbon savings of choosing active transport (walking, cycling) over fossil-fuel vehicles, and will take direct environmental action through plogging.
- **Skills:** Route planning, endurance training, aerobic fitness tracking, carbon-saving calculation, teamwork, and outdoor navigation.
- **GreenComp:** *Acting for sustainability* (Promoting sustainable lifestyles, individual and collective initiative).

- **Materials:** Pedometer or running apps, local cycling and walking route maps, real-time air quality indexes, gloves, reusable collection bags and sorting bins.
- **Lesson Flow:**
 - *Warm-up:* Check the local air quality index and discuss how air pollution affects outdoor athletic performance.
 - *Main Activities:* Plan and test safe walking or cycling routes to school and track calories burned alongside CO₂ emissions avoided. In a plogging unit, teams jog a route around the school, collect litter, and sort it afterwards.
 - *Wrap-up:* Add up the group’s distance, the litter collected and the emissions avoided.
- **Cycling and the Ecological Footprint:** Cycling produces no direct emissions. Every car kilometre replaced by bike saves, as a rough guide, around 150 g of CO₂ for an average petrol car; students should look up current values for their own country. A student who cycles a 5 km school route instead of being driven saves about 1.5 kg of CO₂ per school day (there and back), roughly 250 to 300 kg per school year. Students calculate their own values and discuss what else belongs to the footprint of a bicycle, such as production and maintenance.
- **Plogging: An Annual School Event:** Plogging combines jogging (Swedish *jogga*) with picking up litter (*plocka upp*). Inspired by our Italian partner school in Senigallia, Gymnasium Vogelsang held its first Plogging Day in July 2026 with 120 upper-secondary students. It now takes place every year at the end of the German school year, as a sporting farewell to the school year that leaves the neighbourhood cleaner than before (see Chapter 8.3 and Chapter 10, Project 9).
- **“We Run to Our Partner Schools”:** Students run the distance between the partner schools symbolically. Every kilometre run in PE lessons, at the Plogging Day or in the school’s free time is added to a shared counter. Each school runs “towards” the others, starting from its own location:

Route	Straight-line distance (approx.)
Solingen → Senigallia	950 km
Senigallia → Tavşanlı	1,430 km
Tavşanlı → Solingen	2,160 km
Full partnership circuit	about 4,540 km

A progress map in the school hallway shows how far the class or the school has “travelled”. Example: 120 students who each run 5 km at the Plogging Day cover 600 km, which is more than half of the way from Solingen to Senigallia in a single morning.

- **Idea in Progress: A Cycling Reward App:** Inspired by our Turkish partner school in Tavşanlı, Gymnasium Vogelsang is exploring an app that rewards students for cycling to school, for example with points for kilometres cycled and CO₂ saved, which could be added to the “We Run to Our Partner Schools” challenge. We find the idea very promising and are pursuing it further. As it requires the cooperation of the computer science department (see 10. Computer Science), it is still in progress and has not yet been implemented.

- **Assessment:** A personal activity and mobility log that combines fitness goals with measurable reductions in CO₂ emissions, plus a group report on the plogging route (distance, amount and type of litter, observations).
- **Extension:** Launch a school-wide active transport campaign that tracks the total emissions avoided each month. In physics, calculate the energy the runners used (see the Cross-Curricular Link in 2. Physics and Lesson Plan 11).
- **Reflection:** How do the way our towns are built and our everyday choices help or hinder our ability to live healthy, low-carbon lives?

14. Technology

- **Connection:** Designing eco-friendly structures, auditing building efficiency, and prototyping physical solutions that support the circular economy.
- **Learning Outcomes:** Students will build insulated architectural scale models that maximise passive solar heating and minimise thermal loss.
- **Skills:** Architectural scale model design, structural insulation auditing, spatial layout planning, and materials engineering.
- **GreenComp:** *Envisioning sustainable futures* (Eco-design, structural adaptation).
- **Materials:** Non-toxic insulation materials, temperature data loggers, cardboard scaling blocks, and drafting software.
- **Lesson Flow:**
 - *Warm-up:* Analyse how poor insulation and drafty windows waste heating energy in public facilities.
 - *Main Activities:* Design and build a scaled architectural model, testing different insulation layouts to see which design retains heat best under thermal testing.
 - *Wrap-up:* Graph thermal retention trends across all student models to find the most efficient design.
- **Assessment:** Technical review evaluating structural stability, material optimisation, and the thermal efficiency of the model design.
- **Extension:** Conduct an audit of thermal loss points across the school building using an infrared imaging camera.
- **Reflection:** How can implementing eco-design principles help lower the lifetime carbon footprint of urban infrastructure?

15. Entrepreneurship

- **Connection:** Developing circular business plans, conducting sustainability market assessments, and understanding the core requirements of corporate environmental responsibility.
- **Learning Outcomes:** Students will pitch a startup concept built entirely on circular economy principles, detailing its operational model and material life cycles.

- **Skills:** Business lifecycle planning, sustainable market analysis, cost-benefit computation, and professional pitch delivery.
- **GreenComp:** *Acting for sustainability* (Sustainable value creation, economic scaling).
- **Materials:** Circular business model canvases, current market trend reports, and product design evaluation templates.
- **Lesson Flow:**
 - *Warm-up:* Identify real-world examples of companies that turn industrial manufacturing waste into new consumer products.
 - *Main Activities:* Build out a circular business plan canvas, ensuring the product is designed for disassembly, repair, and eventual material recovery.
 - *Wrap-up:* Deliver a 3-minute pitch explaining how the startup prevents waste generation.
- **Assessment:** A comprehensive circular business plan reviewed on its market viability and full-lifecycle environmental footprint.
- **Extension:** Partner with local businesses to redesign their commercial packaging options using localised waste streams.
- **Reflection:** How can we change traditional business metrics so that environmental protection is valued alongside financial profit?

16. Philosophy

- **Connection:** Examining environmental ethics, anthropocentrism vs. biocentrism, climate justice, and our moral responsibilities to future generations.
- **Learning Outcomes:** Students will critique competing ethical positions regarding resource use and defend a philosophical position on global climate justice.
- **Skills:** Ethical critique, dialectical argumentation, logical premise evaluation, and deconstruction of ideological worldviews.
- **GreenComp:** *Embodying sustainability values* (Ethical assessment, social justice equity).
- **Materials:** Foundational philosophical texts on environmental ethics and case studies highlighting climate vulnerability imbalances.
- **Lesson Flow:**
 - *Warm-up:* Discuss who bears moral responsibility for environmental damage when actions are driven by historic systematic choices.
 - *Main Activities:* Run a structured philosophical seminar comparing anthropocentric (human-centred) and biocentric (nature-centred) views on resource stewardship.
 - *Wrap-up:* Summarise how individual ethical frameworks directly shape public policy choices.

- **Assessment:** Philosophical essay analysing our moral obligation to future generations regarding resource protection.
- **Extension:** Draft an environmental ethics code of conduct to serve as a guide for future school policy and student projects.
- **Reflection:** How can shifting our underlying worldview from conquering nature to living within planetary boundaries change our environmental laws?

17. Literature

- **Connection:** Analysing climate fiction (*cli-fi*) and ecological poetry to explore human emotional responses to environmental degradation and resource futures.
- **Learning Outcomes:** Students will identify recurring environmental themes and tropes in contemporary climate fiction and analyse how literature drives public environmental awareness.
- **Skills:** Textual analysis, narrative decoding, creative writing, and thematic synthesis.
- **GreenComp:** *Envisioning sustainable futures* (Creative projection, narrative exploration).
- **Materials:** Excerpts from climate fiction novels, dystopian/utopian short stories, and eco-critical essay selections.
- **Lesson Flow:**
 - *Warm-up:* Discuss how speculative fiction stories can make complex scientific data feel immediate and personal.
 - *Main Activities:* Read and analyse an excerpt of climate fiction, evaluating how the author uses setting and narrative arc to explore resource scarcity issues.
 - *Wrap-up:* Brainstorm opening scenes for an original short story set in a sustainable future city.
- **Assessment:** Portfolio containing a textual analysis essay and an original piece of environmental speculative fiction.
- **Extension:** Host a school-wide reading group or creative writing competition focused entirely on positive environmental futures.
- **Reflection:** How can stories help us move past eco-fatalism toward actively building sustainable communities?

18. French and Other Foreign Languages

- **Connection:** Foreign language lessons open a window onto how other countries experience and tackle climate change. Learners compare national approaches to climate protection, recycling and renewable energy, and place them in the European context of climate neutrality by 2050. The model is described for French but applies equally to English, Italian, Spanish, Turkish or any other foreign language taught.
- **Learning Outcomes:** Students will describe and compare how a target-language country deals with climate change, waste and energy; identify strengths and

weaknesses of national strategies; and explain the difference between EU member states, which are legally bound by EU climate law, and non-EU countries, which pursue similar goals on the basis of national commitments.

- **Skills:** Reading and listening comprehension of authentic media, mediation, comparative analysis, argumentation and debate, and presentation in the target language.
- **GreenComp:** *Embracing complexity in sustainability* (Systems thinking, critical thinking); *Envisioning sustainable futures* (Futures literacy).
- **Materials:** Authentic articles, videos and infographics from the target-language country (e.g., for French: ADEME, Ministère de la Transition écologique, *Le Monde Planète*, TV5MONDE), the EU Climate Action portal and the Climate Action Tracker country profiles.
- **Lesson Flow:**
 - *Warm-up:* Brainstorm the target-language vocabulary of climate, waste and energy (*le réchauffement climatique, le tri sélectif, les énergies renouvelables, la neutralité carbone*).
 - *Main Activities:* Expert groups each research one country (e.g., France, Germany, Italy, Türkiye) under three headings: climate policy, recycling, renewable energy. They fill in a strengths/weaknesses grid and present it in the target language.
 - *Wrap-up:* Class discussion: Which country could learn what from which? What does “climate neutral by 2050” mean in practice?
- **Strengths and Weaknesses: An Example Grid:**

Country	Strengths (examples)	Weaknesses / Challenges (examples)
France	Very low-carbon electricity thanks to nuclear power and hydropower; climate neutrality by 2050 written into law (<i>loi énergie-climat</i> , 2019)	Slower expansion of wind and solar than planned; debate about the future of nuclear power; emissions from transport and buildings
Germany	Climate neutrality target set for 2045 (Federal Climate Change Act); high share of renewable electricity; well-established waste separation and deposit system	Coal phase-out still under way (lignite, e.g., Garzweiler); transport sector emissions; grid expansion
Italy	Strong solar potential; tradition of reuse and creative upcycling; regional separate collection systems	Heavy reliance on natural gas; large regional differences in waste management
Türkiye	Rapid growth of solar, wind and geothermal energy; zero-waste initiative (<i>Sıfır Atık</i>)	Coal still important in the energy mix; growing energy demand

Note for teachers: The grid gives starting points only. Students should verify and update all facts with current sources, as national policies change quickly.

- **Europe and the 2050 Goal: EU and Non-EU Countries:** All four partner countries have signed the Paris Agreement and pursue the same long-term goal of climate neutrality around the middle of the century. The difference lies in how binding that goal is:
 - *EU member states (France, Germany, Italy):* The European Climate Law (Regulation (EU) 2021/1119) makes climate neutrality by 2050 legally binding for the Union as a whole, with an interim target of at least 55% net emission reduction by 2030 compared with 1990. EU legislation (e.g., emissions trading, recycling quotas, renewable energy targets) applies directly or must be transposed into national law, and compliance can be enforced through EU procedures. Students should therefore refer explicitly to EU law when assessing EU countries.
 - *Non-EU countries (e.g., Türkiye):* Türkiye has set its own target of net-zero emissions by 2053 and adopted a national climate law in 2025. As an EU candidate country, it is gradually aligning with EU standards, but EU climate law is not binding there. Its commitments rest on national legislation and on international agreements.
- **Assessment:** Presentation or written comparison in the target language, evaluated on content accuracy, use of climate vocabulary and quality of argumentation.
- **Extension:** Exchange short video messages with a partner school in which students present their country's climate efforts in the partner's language, or via eTwinning.
- **Reflection:** Does a shared European legal framework make climate action more effective, or do national approaches allow more creativity?

19. Languages of Schooling: German, Italian and Turkish

- **Connection:** In their first language or language of schooling, students engage with the contemporary climate debate as it appears in newspapers and in literature. This complements the more classical approach in 8. Turkish and 17. Literature with current texts from the three partner countries.
- **Learning Outcomes:** Students will analyse how climate change, energy and waste are presented in current newspaper articles and commentaries, and how contemporary authors, poets and songwriters deal with the climate crisis. They will compare perspectives across the three countries.
- **Skills:** Text analysis of non-fiction and fiction, media criticism, argumentation, creative writing, and intercultural comparison.
- **GreenComp:** *Embodying sustainability values* (Valuing sustainability); *Embracing complexity in sustainability* (Critical thinking).
- **Materials:** Current articles and commentaries from national and regional newspapers (e.g., German, Italian and Turkish daily newspapers and their online climate sections), and contemporary literary texts, poems, songs or comics on climate change chosen by the teacher in each country.

- **Lesson Flow:**
 - *Warm-up:* Students collect headlines on climate and energy from the past week and sort them by tone (alarming, factual, hopeful, dismissive).
 - *Main Activities:* Close reading of one newspaper text (structure, arguments, rhetorical devices, framing) and one contemporary literary text (images, narrative perspective, emotional effect). Groups compare how the two genres address the same topic.
 - *Wrap-up:* Each group writes a short commentary or poem of its own on a climate topic from its region.
- **Assessment:** Text analysis or commentary (written), or a creative text with an author's commentary.
- **Extension:** Partner schools exchange their students' texts. Each class translates or summarises one text from a partner school and compares how the climate debate differs between Germany, Italy and Türkiye.
- **Reflection:** How does the language we use about climate change (crisis, catastrophe, transition, opportunity) influence how we act?

CHAPTER 5: READY-TO-USE LESSON PLANS

This chapter contains 13 comprehensive, practice-oriented lesson plans designed to provide teachers with highly detailed blueprints for immediate execution. Moving beyond superficial ideas, these plans follow an exhaustive pedagogical format to meet rigorous instructional standards across secondary education contexts.

5.1 Lesson Plan Index

Lesson length: At the partner schools in Türkiye and Italy, a lesson block lasts 90 minutes (2 × 45 minutes); at Gymnasium Vogelsang in Solingen, a lesson lasts 67.5 minutes. Each lesson plan is therefore designed for 90 minutes and includes an adapted timing for 67.5-minute lessons.

Lesson plans 1–10 correspond to the first ten academic disciplines detailed in the integration matrix of Chapter 4. Lesson plans 11–13 were added on the basis of the partner schools’ experiences during the project (Physical Education, Foreign Languages and Languages of Schooling):

1. **Mathematics:** Statistical Modelling of Carbon Footprints
2. **Physics:** Thermodynamics and the Enhanced Greenhouse Effect
3. **Chemistry:** Chemical Kinetics of Ocean Acidification
4. **Biology:** Shifting Ecosystems and Regional Biodiversity Vectors
5. **Geography:** GIS Mapping of Global Deforestation and Sea-Level Rise
6. **History:** The Industrial Revolution and Carbon-Intensive Economic History
7. **English:** Rhetorical Analysis and Greenwashing in Modern Climate Media
8. **Turkish:** Eco-literary Analysis of Traditional and Modern Textual Landscapes
9. **ICT:** Digital Resource Accountability and Database Systems for Paper Auditing
10. **Computer Science:** Algorithmic Optimisation and Smart Grid Power Load Automation
11. **Physical Education (with Physics):** Plogging and “We Run to Our Partner Schools”
12. **French and Other Foreign Languages:** Climate Action Across Borders: Strengths, Weaknesses and the 2050 Goal
13. **Languages of Schooling (German, Italian, Turkish):** The Climate Debate in Today’s Newspapers and Literature

5.2 Comprehensive Lesson Blueprints

LESSON PLAN 1: MATHEMATICS

- **Lesson Title:** Statistical Modelling of Carbon Footprints

- **Duration:** 90 minutes in Türkiye and Italy (2×45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will calculate personal and institutional carbon footprints by transforming diverse utility indicators into metric tons of CO₂ equivalents (CO₂e).
 - Students will construct linear equations forecasting institutional greenhouse gas accumulation profiles based on varying demographic growth indices.
- **Materials:** Global carbon conversion factors datasheet spreadsheets, localised institutional electrical and natural gas consumption billing records, graphing calculators, and digital laptops with spreadsheet software.
- **Warm-up (15 Minutes):** Present a raw, multi-variable scatter plot displaying global per-capita emission volumes against national Gross Domestic Product (GDP) indexes. Guide students through a structured inquiry process to isolate the mathematical trends, defining what constitutes a carbon dioxide equivalent (CO₂e).
- **Activities (50 Minutes):**
 - *Activity A: Institutional Consumption Analysis (25 Mins):* Divide students into investigative teams. Provide each team with the school's historical electricity and heating records. Students apply strict conversion multipliers (e.g., kWh $\times$ local grid emission factor) to determine the baseline emission profiles.
 - *Activity B: Linear Predictive Modelling (25 Mins):* Students derive a first-degree linear equation ($y = mx + b$) where the independent variable (x) represents the school's total student enrollment and y represents total predicted emissions. Teams plot this projection to identify where the school will reach emission limits over a five-year horizon.
- **Assessment (15 Minutes):** Provide a raw dataset representing a mock neighborhood's daily energy metrics. Students must independently isolate anomalies, convert the metrics into metric tons of CO₂e, and calculate the median and variance of the dataset.
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Complete a comprehensive home carbon ledger audit over a seven-day period, computing total household emissions across electrical, heating, and vehicle categories.
- **Differentiation:** Advanced students incorporate exponential decay variables modelling the implementation of solar panel arrays; scaffolding models provide pre-

structured algebraic formulas and direct conversion look-up sheets for struggling learners.

- **Teacher Notes:** Ensure local conversion constants match current national energy grid mix values to guarantee scientific and mathematical precision.

LESSON PLAN 2: PHYSICS

- **Lesson Title:** Thermodynamics and the Enhanced Greenhouse Effect
- **Duration:** 90 minutes in Türkiye and Italy (2×45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will calculate thermal energy retention rates using laboratory models simulating distinct atmospheric gas concentration vectors.
 - Students will apply the Stefan-Boltzmann law to model radiation absorption and emission dynamics within closed atmospheric simulations.
- **Materials:** Specialised digital infrared thermometers, glass container cells, pure carbon dioxide canister sources, high-intensity halogen heat lamps, digital multimeters, and mini-photovoltaic panels.
- **Warm-up (15 Minutes):** Present a diagram showing solar radiation passing through the atmosphere versus thermal infrared radiation being absorbed and re-emitted by greenhouse gases. Review the difference between ultraviolet and infrared wavelengths.
- **Activities (50 Minutes):**
 - *Activity A: Greenhouse Simulation Labs (25 Mins):* Construct two physical laboratory models using sealed glass containers under identical halogen light sources. Pump carbon dioxide into one container while leaving the second with regular ambient air. Students use infrared probes to log the temperature curves of both environments every 60 seconds.
 - *Activity B: Photovoltaic Incidence Efficiency (25 Mins):* Connect mini solar panels to digital multimeters. Measure the changes in electrical power output as the panel is tilted at varying angles relative to the heat source, mapping the mathematical relationship between the angle of incidence and electrical efficiency.
- **Assessment (15 Minutes):** Students complete a technical graph detailing the temperature curves from Activity A and write an explanatory paragraph connecting the slope changes directly to thermal absorption mechanics.
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the

activities by reducing the number of examples or by assigning part of the work as homework.

- **Homework:** Draft a formal lab report outlining the thermodynamics of heat-trapping mechanisms within the Earth's atmosphere.
- **Differentiation:** Provide interactive computer simulations for tactile or visual learners; assign advanced students the task of mathematically modelling the specific heat capacity changes of the air samples.
- **Teacher Notes:** Ensure both containers are fully sealed to prevent gas leakage from throwing off the validity of the temperature logs.

LESSON PLAN 3: CHEMISTRY

- **Lesson Title:** Chemical Kinetics of Ocean Acidification
- **Duration:** 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will write and balance the complete chemical pathway for the formation of carbonic acid from dissolved carbon dioxide gas ($\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{HCO}_3^- + \text{H}^+$).
 - Students will calculate changes in hydrogen ion concentrations ($[\text{H}^+]$) based on digital pH monitoring of aquatic systems under high- CO_2 conditions.
- **Materials:** High-precision digital pH meters, universal chemical indicator drops, distilled water, calcium carbonate fragments (representing marine shells), gas straws, and safety goggles.
- **Warm-up (15 Minutes):** Introduce a visual diagram showing how rising atmospheric carbon dioxide levels directly impact the pH balance of the global ocean system. Review how logarithmic changes in pH values correspond to actual changes in ion concentrations.
- **Activities (50 Minutes):**
 - *Activity A: Carbonic Acid Synthesis (25 Mins):* Fill separate beakers with distilled water containing universal indicator solutions. Students use straws to bubble exhaled breath (CO_2) into the water for set intervals, tracking the colour changes and logging the exact pH drop with digital metres.
 - *Activity B: Calcium Carbonate Dissolution (25 Mins):* Submerge matching calcium carbonate shell fragments in liquids of varying acidity levels. Students observe the reactions, measure mass loss over time, and map out how lower pH water speeds up the destruction of shell-building organisms.
- **Assessment (15 Minutes):** Written test requiring students to accurately draw out the full equilibrium equation for ocean acidification and explain why excess H^+ ions block marine calcification processes.

- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Create a detailed chemical lifecycle map explaining how burning fossil fuels in cities leads to the structural decay of coral reef systems.
- **Differentiation:** Visual learners use colour-coded molecular building blocks to model the shift from carbonic acid to bicarbonate; advanced students use data to calculate the reaction rates of calcium carbonate across different acidities.
- **Teacher Notes:** Emphasise proper laboratory safety protocols, ensuring safety goggles are worn at all times when handling acidic solutions.

LESSON PLAN 4: BIOLOGY

- **Lesson Title:** Shifting Ecosystems and Regional Biodiversity Vectors
- **Duration:** 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will measure species richness and distribution shifts using standard field quadrat sampling across designated microclimate zones.
 - Students will analyse how changing climate variables disrupt critical timing links within local food webs.
- **Materials:** Standard 1-metre square wooden quadrat grids, regional plant and insect identification guides, magnifying lenses, and ecological mapping software applications.
- **Warm-up (15 Minutes):** Introduce the ecological concept of “trophic mismatches,” using a real-world example of how shifts in temperature can cause insect hatching dates to fall out of sync with bird nesting seasons.
- **Activities (50 Minutes):**
 - *Activity A: Field Quadrat Surveys (25 Mins):* Lead the class to two distinct outdoor zones on the school grounds (e.g., an open lawn under direct sun versus a shaded, damp wooded area). Teams lay down quadrat frames to count, categorise, and log every plant and insect species present.
 - *Activity B: Food Web Vulnerability Mapping (25 Mins):* Using their field logs, teams map out a complex food web. They systematically remove specific climate-sensitive species to analyse how the loss of one link impacts the survival of predators and the system as a whole.

- **Assessment (15 Minutes):** Teams present their completed ecological maps, defending their predictions for how a 2 °C local temperature increase would reshape species distributions.
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Complete an ecological analysis report reviewing how local environmental changes threaten a specific endangered species native to the region.
- **Differentiation:** Provide illustrative identification sheets for students who struggle with taxonomy; advanced students use their field counts to calculate formal biodiversity indexes (e.g., Simpson's Index).
- **Teacher Notes:** Remind students to respect the natural environments they are studying and to leave the survey areas exactly as they found them.

LESSON PLAN 5: GEOGRAPHY

- **Lesson Title:** GIS Mapping of Global Deforestation and Sea-Level Rise
- **Duration:** 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will analyse changing landscapes over time by using open-source Geographic Information Systems (GIS) to track deforestation rates in vital carbon basins.
 - Students will evaluate the socioeconomic impacts of rising sea levels on coastal cities by layering demographic and elevation maps.
- **Materials:** Laptops with reliable internet access, accounts for open-source digital mapping platforms (e.g., Google Earth Engine), satellite time-lapse datasets, and regional elevation data models.
- **Warm-up (15 Minutes):** Show a series of time-lapse satellite images tracking the shrinking boundaries of major rainforests or glaciers over the past 30 years. Teach students how to read and interpret satellite colouration profiles.
- **Activities (50 Minutes):**
 - *Activity A: Tracking Canopy Loss with GIS (25 Mins):* Students log into the GIS platform to examine a specific region over a multi-decade timeframe. They map and calculate the square kilometres of forest canopy lost, converting that data into estimated reductions in global carbon sink capacity.

- *Activity B: Coastal Sea-Level Inundation Layers (25 Mins)*: Students switch to a topographic map layer of a major coastal low-altitude city. They simulate 1-metre and 2-metre increases in sea level, highlighting which industrial, residential, and agricultural zones would be flooded and estimating the displaced population numbers.
- **Assessment (15 Minutes)**: Students submit a structured digital map layout that cleanly highlights their chosen city's climate risk zones alongside a written summary of key geographic vulnerabilities.
- **Wrap-up and Reflection (10 Minutes)**: Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang)**: Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework**: Write a geography case study analysing how changing climate conditions drive shifts in regional crop production and migration patterns.
- **Differentiation**: Provide step-by-step video walk-throughs for students navigating the GIS software interfaces; assign advanced students to layer economic data grids over the flooded zones to calculate estimated financial infrastructure damage.
- **Teacher Notes**: Confirm that the school's internet network can handle multiple devices loading high-resolution satellite imagery simultaneously before starting the lesson.

LESSON PLAN 6: HISTORY

- **Lesson Title**: The Industrial Revolution and Carbon-Intensive Economic History
- **Duration**: 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives**:
 - Students will analyse historical primary documents to trace how switching from wood and muscle power to fossil fuel engines altered global carbon emission paths.
 - Students will evaluate how early industrial ideas of endless progress contributed to modern systemic resource choices.
- **Materials**: Excerpts from 19th-century industrial factory records, historical coal production logs, early legislative acts on energy use, and graphs showing long-term atmospheric carbon trends.
- **Warm-up (15 Minutes)**: Project a graph showing global carbon emissions side-by-side with a timeline of major industrial breakthroughs (like the steam engine and coal-powered factories). Have students identify the exact historical points where carbon accumulation began to accelerate sharply.

- **Activities (50 Minutes):**
 - *Activity A: Primary Source Document Reviews (25 Mins):* Divide students into analytical groups. Provide each group with primary sources from the 1800s, including factory owner statements, worker diaries, and early economic essays. Students evaluate how these sources prioritised rapid manufacturing growth over environmental impacts.
 - *Activity B: Historical Carbon Mapping (25 Mins):* Teams trace how early investments in coal-powered rail and shipping networks established the infrastructure choices that lock modern economies into fossil fuel dependence today.
- **Assessment (15 Minutes):** A structured writing task where students explain how the resource decisions made during the Industrial Revolution directly shaped the environmental challenges we face today.
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Write an essay analysing the historical connection between global industrialisation patterns and current debates over international climate justice.
- **Differentiation:** Provide guided reading templates with summarised sections for students who struggle with historical texts; advanced students can critique the early environmental warning perspectives of writers from that era.
- **Teacher Notes:** Guide students to look past modern perspectives, encouraging them to analyse how historical actors understood progress, resource limits, and economic growth within their own time periods.

LESSON PLAN 7: ENGLISH

- **Lesson Title:** Rhetorical Analysis and Greenwashing in Modern Climate Media
- **Duration:** 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will identify classic corporate greenwashing tactics in advertising by deconstructing the rhetorical strategies used to frame sustainability claims.
 - Students will craft an evidence-based persuasive speech that challenges environmental misinformation using verified scientific data points.
- **Materials:** A selection of current print and video advertisements containing environmental claims, transcripts of recent climate speeches, and laptops with access to peer-reviewed science databases.

- **Warm-up (15 Minutes):** Introduce the “Seven Sins of Greenwashing” framework (such as using hidden trade-offs, vague language, or irrelevant eco-labels). Analyse a sample advertisement together as a class to spot these deceptive communication techniques.
- **Activities (50 Minutes):**
 - *Activity A: Deconstructing Media Claims (25 Mins):* Pairs of students choose a specific advertisement or corporate environmental report. They isolate terms like “eco-friendly,” “natural,” or “net-zero,” checking these marketing claims against primary scientific data to separate genuine action from greenwashing.
 - *Activity B: Writing Persuasive Speeches (25 Mins):* Students write a short, powerful speech targeting a specific environmental issue. They structure their arguments around the rhetorical triangle, using ethos (credibility via accurate data), logos (logical problem-solving), and pathos (inspiring collective values).
- **Assessment (15 Minutes):** Students deliver a 1-minute summary presentation detailing the specific greenwashing tactics discovered in their assigned media source.
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Finalise the written text of the persuasive speech, ensuring all scientific data points are backed up by accurate citations.
- **Differentiation:** Provide fill-in-the-blank rhetorical outlines for students who need writing support; advanced students can analyse how subtle choices in tone and framing shape public perception of climate policies.
- **Teacher Notes:** Encourage students to maintain an objective, critical stance, evaluating the specific language choices and factual support behind claims rather than relying on personal opinions.

LESSON PLAN 8: TURKISH

- **Lesson Title:** Eco-literary Analysis of Traditional and Modern Textual Landscapes
- **Duration:** 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will analyse themes of environmental stewardship in classical and modern Turkish literature, identifying changing cultural values regarding the land.
 - Students will write a text critique focused on how nature is represented in traditional and modern literary works.

- **Materials:** Print copies of Aşık Veysel's poem "Kara Toprak," selected short stories from modern environmental writers, and structural text analysis rubrics.
- **Warm-up (15 Minutes):** Recite key lines from "Kara Toprak" as a class. Guide students through an initial brainstorm on how traditional oral literature portrays soil and natural systems as living, giving entities rather than commodities to be exploited.
- **Activities (50 Minutes):**
 - *Activity A: Textual Critique (25 Mins):* Students work in groups to analyse selected literary pieces. They note specific metaphors, descriptive language, and themes to compare how classical nature writing differs from modern literature, which often addresses environmental loss and industrial degradation.
 - *Activity B: Creative Eco-Writing (25 Mins):* Using traditional poetic structures or modern prose formats, students write an original literary piece that addresses a current environmental issue facing their home community.
- **Assessment (15 Minutes):** Students present their creative writing pieces, explaining the specific literary devices they chose to convey their environmental message.
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Write a formal literary review comparing how two authors from different eras address the relationship between human progress and natural systems.
- **Differentiation:** Provide structured graphic organisers to guide text analysis; advanced students can apply advanced eco-critical frameworks to critique contemporary environmental journalism.
- **Teacher Notes:** Encourage students to explore the emotional power of their native language, focusing on how specific vocabulary choices can build deep community connection and inspire environmental care.

LESSON PLAN 9: ICT

- **Lesson Title:** Digital Resource Accountability and Database Systems for Paper Auditing
- **Duration:** 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will estimate the hidden carbon footprint of everyday digital activities (e-mails, cloud storage, video streaming) and of device lifecycles.

- Students will build a functional spreadsheet database that tracks the school’s paper consumption by department and visualises trends.
- **Materials:** Laptops with spreadsheet software, published estimates of digital emissions, the school’s paper purchase or printing records (anonymised), and a template for a data dashboard.
- **Warm-up (15 Minutes):** Students estimate how many e-mails, photos and streaming hours they produce in a week. The class then compares their guesses with published estimates of the energy used by data centres and networks, and discusses why digital does not mean emission-free.
- **Activities (50 Minutes):**
 - *Activity A: Building the Paper Audit Database (25 Mins):* Teams design a table structure (department, month, sheets printed, paper type, recycled share), enter the sample data, and create formulas for totals, averages and CO₂e estimates using a standard emission factor per sheet.
 - *Activity B: Dashboard and Recommendations (25 Mins):* Teams build charts showing consumption by department and month, identify the largest “paper hotspots”, and formulate three concrete digital or organisational measures to reduce paper use.
- **Assessment (15 Minutes):** Teams present their dashboards; the assessment considers correct data structure, working formulas, clarity of visualisation and the quality of the recommendations.
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Keep a one-week “digital footprint diary” and identify two personal habits that could reduce data-related energy use.
- **Differentiation:** Provide a pre-built table with prepared formulas for students who need support; advanced students add automated conditional formatting or connect a form for live data entry.
- **Teacher Notes:** Emission factors for digital services vary widely between sources. Discuss these uncertainties openly with students, as this itself is an important lesson in data literacy.

LESSON PLAN 10: COMPUTER SCIENCE

- **Lesson Title:** Algorithmic Optimisation and Smart Grid Power Load Automation
- **Duration:** 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)

- **Objectives:**
 - Students will write an algorithm that switches school lighting and heating on or off according to room occupancy data.
 - Students will compare the simulated energy savings of different algorithms and evaluate their efficiency.
- **Materials:** Python or a block-based programming environment, sample occupancy data for several classrooms (timetable-based), micro:bits or a micro:bit simulator, and an energy consumption table for lighting and heating.
- **Warm-up (15 Minutes):** Discuss where electricity is wasted in the school building (lights in empty rooms, heating during breaks) and how sensors and software could prevent this.
- **Activities (50 Minutes):**
 - *Activity A: Coding the Controller (25 Mins):* Pairs program a controller that reads occupancy data for each hour and decides whether lights and heating should be on, standby or off. They calculate total kWh for a school day.
 - *Activity B: Optimisation Contest (25 Mins):* Pairs refine their rules (e.g., pre-heating before lessons, daylight thresholds) and run their code on the same dataset. The class compares energy use and comfort criteria to find the best solution.
- **Assessment (15 Minutes):** Code review based on correctness, efficiency and readability, plus a short written explanation of the algorithm's logic and the energy saved.
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Describe in pseudocode how the algorithm could be extended to a smart grid that shifts consumption to times with high solar or wind supply.
- **Differentiation:** Provide partially completed code templates for beginners; advanced students implement the controller on a micro:bit with a light sensor.
- **Teacher Notes:** Link the results to Activity 27 (Phantom Power Hunt) and to real consumption data of the school building where available.

LESSON PLAN 11: PHYSICAL EDUCATION (WITH PHYSICS)

- **Lesson Title:** Plogging and "We Run to Our Partner Schools"

- **Duration:** 90 minutes in Türkiye and Italy (2×45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below); can be held as part of the annual Plogging Day
- **Objectives:**
 - Students will complete a plogging run in teams, collect and sort litter, and document distance and quantities.
 - Students will add their distances to the symbolic “run to our partner schools” and calculate the energy they used, comparing it with a wind turbine and a household’s annual electricity demand.
- **Materials:** Gloves, reusable bags, sorting bins (paper, plastic/packaging, glass, residual waste), running apps or pedometers, a scale, a printed map showing Solingen, Senigallia and Tavşanlı, calculators. Safety: high-visibility vests, a first-aid kit, and a route agreed with the local authority or waste management service in advance.
- **Warm-up (15 Minutes):** Dynamic warm-up and short briefing: what plogging is (Swedish *jogga + plocka upp*), safety rules (no sharp objects or hazardous waste with bare hands; report syringes, broken glass and chemicals to the teacher), and the litter categories.
- **Activities (50 Minutes):**
 - *Activity A: Plogging Run (35 Mins):* Teams of four to five jog a set route around the school at their own pace, stopping to pick up litter. Each team records its distance and fills its bags.
 - *Activity B: Sorting and Counting (15 Mins):* Teams sort and weigh their litter, record the most common items, and add their kilometres to the school’s “partner school counter”.
- **Assessment and Physics Link (15 Minutes and follow-up lesson):** Teams present their results. In the follow-up physics lesson, students calculate their energy use with a simple approximation: running costs about 1 kcal per kilogram of body weight per kilometre. A 60 kg student running 5 km uses about 300 kcal, which is about 0.35 kWh (1 kWh $\approx$ 860 kcal). 120 students at the Plogging Day therefore use about 36,000 kcal, or roughly 42 kWh. Students then compare:
 - *Wind turbine:* A modern onshore wind turbine with a rated power of 4 MW would produce 42 kWh in less than one minute at full output ($42 \text{ kWh} \div 4,000 \text{ kW} \approx 38$ seconds).
 - *Household:* A typical family household uses roughly 3,000 to 4,000 kWh of electricity per year, so 42 kWh is about four to five days of its electricity demand.
 - *Discussion:* Why are human muscles an impressive but very limited energy source? What does this tell us about the scale of energy needed by modern societies, and about the value of saving energy?

- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Calculate the class's progress on the map ("How far have we got towards Senigallia or Tavşanlı?") and write a short report on the litter found: which items were most frequent, and how could they be avoided?
- **Differentiation:** Students choose their own running pace or walk-run intervals; students who cannot run can lead the sorting station or do the data analysis. Advanced students calculate the mechanical work and efficiency of the human body or research real values for the local wind farm.
- **Teacher Notes:** All energy figures are rough approximations for comparison. Students should look up current national values for household consumption and wind turbines. Agree the disposal of the collected waste with the local waste management service in advance.

LESSON PLAN 12: FRENCH AND OTHER FOREIGN LANGUAGES

- **Lesson Title:** Climate Action Across Borders: Strengths, Weaknesses and the 2050 Goal
- **Duration:** 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will describe, in the target language, how France (or another target-language country) deals with climate change, recycling and renewable energy.
 - Students will assess strengths and weaknesses of national strategies and explain the difference between EU member states, which are bound by the European Climate Law, and non-EU countries such as Türkiye, which pursue the same goal through national commitments.
- **Materials:** Short authentic texts and infographics (e.g., ADEME, TV5MONDE, *Le Monde Planète*), a vocabulary list, the strengths/weaknesses grid from Chapter 4 (18. French and Other Foreign Languages), and an EU map.
- **Warm-up (15 Minutes):** Vocabulary activation with a word cloud: *le réchauffement climatique, les émissions de gaz à effet de serre, le tri sélectif, le recyclage, les énergies renouvelables, le nucléaire, la neutralité carbone, d'ici 2050*.
- **Activities (50 Minutes):**
 - **Activity A: Expert Groups (30 Mins):** Four groups research one country each (France, Germany, Italy, Türkiye) under the headings *politique climatique – recyclage – énergies renouvelables* and complete the grid: *points forts / points faibles*.

- *Activity B: The 2050 Goal (20 Mins):* Groups mix (jigsaw method) and compare their countries. Guiding question: *Tous les pays veulent atteindre la neutralité carbone. Mais qui y est obligé – et par quoi ?* Students work out that France, Germany and Italy must comply with EU law (European Climate Law: climate neutrality by 2050, at least –55% by 2030), whereas Türkiye has set its own target (net zero by 2053) as a non-EU country.
- **Assessment (15 Minutes):** Short presentation in the target language (two minutes per group) or a written *synthèse*: *Quel pays est le plus avancé dans la lutte contre le changement climatique ? Justifiez votre réponse.*
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Write a *commentaire* (about 200 words): *L'Union européenne doit-elle imposer des objectifs climatiques à ses États membres ?*
- **Differentiation:** Provide sentence starters (*D'un côté... de l'autre..., Ce qui est positif, c'est que..., Le problème, c'est que...*) and glossaries; advanced students include current statistics and quotations.
- **Teacher Notes:** Check facts and figures against current sources before the lesson, as climate policies change quickly. The lesson works in any foreign language by swapping the target country and the materials.

LESSON PLAN 13: LANGUAGES OF SCHOOLING (GERMAN, ITALIAN, TURKISH)

- **Lesson Title:** The Climate Debate in Today's Newspapers and Literature
- **Duration:** 90 minutes in Türkiye and Italy (2 × 45 minutes); 67.5 minutes at Gymnasium Vogelsang (see timing below)
- **Objectives:**
 - Students will analyse a current newspaper text on climate change, energy or waste in their language of schooling, with a focus on argumentation, framing and rhetorical devices.
 - Students will interpret a contemporary literary text (poem, short story, song lyrics or comic) on the climate crisis and compare its effect with that of the newspaper text.
- **Materials:** One current newspaper article or commentary and one contemporary literary text per country, chosen by the teacher (German, Italian or Turkish), an analysis worksheet and a comparison grid.
- **Warm-up (15 Minutes):** Students sort recent headlines on climate topics by their tone (alarming, factual, hopeful, dismissive) and discuss how word choice shapes their reactions.

- **Activities (50 Minutes):**
 - *Activity A: Newspaper Analysis (25 Mins):* In pairs, students identify the thesis, arguments, evidence, and linguistic means (metaphors such as “climate catastrophe” vs. “energy transition”, appeals, numbers) and assess the text’s position.
 - *Activity B: Literary Perspective (25 Mins):* Groups read the literary text and analyse images, perspective and emotional effect. They compare: What can literature do that a newspaper article cannot, and vice versa?
- **Assessment (15 Minutes):** Groups present their comparison grids; individual written text analysis as a follow-up assignment.
- **Wrap-up and Reflection (10 Minutes):** Students summarise the key insight of the lesson in one sentence and connect it to their own everyday life or to their school (e.g., as an exit ticket).
- **Timing for 67.5-Minute Lessons (Gymnasium Vogelsang):** Warm-up 10 minutes · Activities 40 minutes · Assessment 10 minutes · Wrap-up 7.5 minutes. Shorten the activities by reducing the number of examples or by assigning part of the work as homework.
- **Homework:** Write your own short commentary or poem about a climate issue in your region (e.g., a flood, a forest, a factory, a beach).
- **Differentiation:** Provide shortened texts and guiding questions; advanced students compare two newspapers with different political orientations.
- **Teacher Notes:** Partner schools can exchange their students’ texts (translated or summarised) to show how the climate debate differs between Germany, Italy and Türkiye. This links naturally to Lesson Plan 12.

CHAPTER 6: CLASSROOM ACTIVITIES

This chapter provides 30 practical, highly adaptable classroom activities designed to foster environmental awareness, teamwork, and problem-solving across all grade levels. The activities are divided into six thematic categories to support diverse teaching strategies, balancing active learning with scientific inquiry and creative expression.

6.1 Activity Index by Category

The activities are organised into the following categories, with 5 distinct activities each:

1. **Icebreakers:** Building community and initial awareness.
2. **Games:** Active, gamified learning experiences.
3. **Indoor & Outdoor STEM:** Scientific inquiry, experiments, and field observations.
4. **Debate & Role Play:** Critical thinking, policy analysis, and perspective-taking.
5. **Poster & Project:** Creative dissemination and long-term research.
6. **Challenges & Competitions:** Action-oriented, collaborative problem-solving.

6.2 Structured Classroom Activities

Category 1: Icebreakers

Activity 1: The Carbon Web

- **Target Age:** 10–18 years
- **Duration:** 15 Minutes
- **Materials:** A ball of biodegradable yarn or string.
- **Procedure:** Students stand in a circle. The first student holds the ball of yarn, states a daily action that releases carbon (e.g., driving a car), holds onto the end of the string, and tosses the ball to a peer across the circle. The next student states a connected environmental impact (e.g., rising sea levels) or another action, holding their piece of string and tossing the ball onward. This continues until a complex, visible web is formed among all participants.
- **Expected Outcomes:** Students visualise how individual actions are deeply interconnected with global planetary systems.

Activity 2: Eco-Bingo

- **Target Age:** 6–14 years
- **Duration:** 20 Minutes
- **Materials:** Custom-printed Bingo grids containing sustainable daily habits (e.g., “Rides a bicycle to school,” “Uses a reusable water bottle,” “Composts food scraps”).

- **Procedure:** Students walk around the classroom, talking to peers to find individuals who match the sustainable actions listed in the grid blocks. When a match is found, that peer signs the corresponding square. The first student to complete a full row or column shouts “Eco!” and wins the round.
- **Expected Outcomes:** Breaks the ice while highlighting and validating existing pro-environmental habits within the peer group.

Activity 3: The Fact or Fiction Circle

- **Target Age:** 12–18 years
- **Duration:** 15 Minutes
- **Materials:** None required.
- **Procedure:** The teacher reads aloud a series of environmental statements, some of which are scientifically verified facts and others popular myths or greenwashing claims. Students quickly step to the right if they believe the statement is factual, or to the left if they believe it is fiction. After each move, the teacher reveals the correct scientific consensus.
- **Expected Outcomes:** Activates critical thinking, challenges common environmental misconceptions, and introduces core vocabulary early.

Activity 4: Two Truths and an Action

- **Target Age:** 14–18 years
- **Duration:** 20 Minutes
- **Materials:** Small scrap cards or sticky notes.
- **Procedure:** Working in small groups, each student writes down two true statements regarding their personal resource consumption habits and one actionable change they plan to implement. Group members take turns guessing which statement is the targeted environmental action item, discussing the feasibility of the chosen habit change.
- **Expected Outcomes:** Builds personal accountability and mutual encouragement among peers in a supportive setting.

Activity 5: The Sustainability Human Knot

- **Target Age:** 8–16 years
- **Duration:** 15 Minutes
- **Materials:** None required.
- **Procedure:** Students form close circles, reach across, and hold hands with two different peers to create a tangled “human knot.” Before the group can work together to untangle themselves without letting go, the teacher assigns each participant a specific environmental element (e.g., clean air, soil, water, biodiversity). If one element drops their hands, the entire knot collapses.
- **Expected Outcomes:** An energetic physical metaphor demonstrating ecosystem reliance and the delicate balance of nature.

Category 2: Games

Activity 6: Carbon Footprint Tag

- **Target Age:** 6–12 years
- **Duration:** 25 Minutes
- **Materials:** Coloured jerseys or pinnies.
- **Procedure:** Two students are designated as “Carbon Emissions” (wearing red pinnies) and attempt to tag their classmates. The remaining students run freely. If tagged, a student must freeze in place, representing an accumulating carbon footprint. Frozen students can be unfrozen only if a free peer tags them and names a specific carbon reduction strategy (e.g., planting native trees or switching to solar energy).
- **Expected Outcomes:** A high-energy physical game that helps students memorise basic carbon mitigation strategies.

Activity 7: Waste Sorting Relay

- **Target Age:** 6–14 years
- **Duration:** 30 Minutes
- **Materials:** Clean, mixed waste items (paper packaging, aluminium cans, plastic bottles, organic matter) and marked sorting bins.
- **Procedure:** Divide the class into competing relay teams. Place a mixed pile of clean waste materials at the opposite end of the room or yard. One by one, students sprint to the pile, select a single piece of waste, race back, and drop it into the correct sorting bin (Recycling, Compost, or Landfill). The team that sorts all items quickest and with the highest accuracy wins.
- **Expected Outcomes:** Turns waste sorting skills into a fast-paced habit, reinforcing the school’s recycling protocols.

Activity 8: The Circular Economy Board Game

- **Target Age:** 10–16 years
- **Duration:** 45 Minutes
- **Materials:** Printable board maps, player tokens, and action decks featuring production scenarios.
- **Procedure:** Students navigate a game board representing a typical factory lifecycle. Landing on “Linear Tasks” forces players to pay resource tax penalties for discarding waste. Landing on “Circular Decisions” rewards players for designing modular products, repairing broken equipment, and upcycling manufacturing outputs back into the production loop.
- **Expected Outcomes:** Teaches the financial and ecological advantages of circular business operations over traditional linear models.

Activity 9: Climate Jeopardy

- **Target Age:** 12–18 years

- **Duration:** 40 Minutes
- **Materials:** Interactive digital presentation screen or board cards.
- **Procedure:** Set up a classic Jeopardy game grid with categories matching core concepts: Greenhouse Effect, Renewable Energy, Biodiversity, and Green Skills. Teams choose point values and must phrase their answers in the form of a question. Point values scale with the difficulty of the scientific concept.
- **Expected Outcomes:** A fun, competitive way to review and test content mastery before formal exams.

Activity 10: Tragedy of the Commons Simulation

- **Target Age:** 14–18 years
- **Duration:** 30 Minutes
- **Materials:** A central bowl filled with small tokens (representing a shared fishery or forest resource).
- **Procedure:** Four students sit around a bowl. Each round, they can harvest up to 3 tokens to earn points. Between rounds, the remaining tokens double to simulate natural resource regeneration. If players greedily harvest max tokens early, the pool empties completely and everyone loses. Students run multiple trials to test how setting shared rules alters the outcome.
- **Expected Outcomes:** Introduces resource management ethics and demonstrates the systemic need for environmental regulations.

Category 3: Indoor & Outdoor STEM

Activity 11: The Solar Cooker Prototype

- **Target Age:** 12–18 years
- **Duration:** 60 Minutes
- **Materials:** Upcycled shoe boxes, heavy aluminium foil, black construction paper, clear plastic wrap, and tape.
- **Procedure:** Students apply physics principles to build an insulated solar cooker. They line the box interior with black paper to absorb heat, use aluminium foil to reflect sunlight into the centre, and seal the top with clear plastic wrap to trap infrared radiation. Teams place their cookers outdoors in direct sunlight to measure internal temperature changes over time.
- **Expected Outcomes:** Demonstrates the practical applications of solar thermal energy and the mechanics of the greenhouse effect.

Activity 12: Microplastic Water Filtration Lab

- **Target Age:** 10–16 years
- **Duration:** 45 Minutes

- **Materials:** Cut plastic water bottles, washed coarse sand, gravel, activated charcoal filters, mesh screens, and muddy water samples mixed with colourful eco-glitter (representing microplastics).
- **Procedure:** Students design a multi-layered gravity water filter inside an inverted plastic bottle. They layer gravel, sand, and charcoal over the mesh opening, pour the contaminated water through the top, and evaluate the filtered output for clarity and plastic removal.
- **Expected Outcomes:** Explains the mechanics of water purification systems and highlights the persistent challenge of microplastic pollution.

Activity 13: Local Heat Island Field Audit

- **Target Age:** 12–18 years
- **Duration:** 50 Minutes
- **Materials:** Handheld digital infrared surface thermometers and data logging sheets.
- **Procedure:** Take students outdoors onto the school grounds. Teams measure and log surface temperatures across different materials: dark asphalt parking spaces, concrete walkways, shaded brick walls, and open grass lawns. Students chart the data to identify micro-climates and urban heat island effects.
- **Expected Outcomes:** Connects landscape design choices directly with local heat retention and energy needs.

Activity 14: DIY Wind Turbine Efficiency Experiment

- **Target Age:** 14–18 years
- **Duration:** 90 Minutes
- **Materials:** Small hobby DC motors, adjustable card stock blades, multi-speed electric fans, and digital multimeters.
- **Procedure:** Students cut and shape custom turbine blades from stiff card stock and mount them onto a hobby motor shaft. They place their prototype in front of a fan, measuring the generated voltage output on a multimeter. Teams experiment with blade counts, lengths, and angles to find the most efficient design for power generation.
- **Expected Outcomes:** Teaches aerodynamics, kinetic-to-electrical energy conversion, and renewable energy engineering principles.

Activity 15: Schoolyard Biodiversity Quadrat Survey

- **Target Age:** 8–16 years
- **Duration:** 60 Minutes
- **Materials:** 1-metre square string quadrat frames, magnifying glasses, and local plant/insect identification field guides.
- **Procedure:** Students lay down survey quadrat frames across different outdoor zones on campus. They count, catalogue, and log every unique living organism found within the square. Groups compare data across zones to analyse how human foot traffic and landscaping impact biodiversity.

- **Expected Outcomes:** Develops field biology skills and builds appreciation for local biodiversity conservation.

Category 4: Debate & Role Play

Activity 16: Mock UN Climate Summit (COP)

- **Target Age:** 14–18 years
- **Duration:** 90 Minutes
- **Materials:** Country profile sheets, country flags, and a text template for a formal climate resolution.
- **Procedure:** Students take on roles as diplomatic delegates representing nations with differing economic and geographic interests (e.g., developing island nations, heavily industrialised powers, oil-producing states). They debate global carbon reduction targets, negotiate financial support funds, and attempt to draft and vote through a joint climate treaty.
- **Expected Outcomes:** Builds geopolitical perspective, negotiation skills, and an understanding of the complexities of international climate treaties.

Activity 17: Town Hall Energy Council

- **Target Age:** 12–18 years
- **Duration:** 60 Minutes
- **Materials:** Role cards for community stakeholders.
- **Procedure:** Set up a mock town meeting focused on a proposal to build a wind farm near a scenic nature reserve. Students take on specific stakeholder roles: local business owners, environmental activists, wind energy developers, and concerned neighborhood residents. Each group presents their case to a student panel acting as the Town Council, which must vote on the final project adjustments.
- **Expected Outcomes:** Develops perspective-taking, critical thinking, and balances local economic goals with conservation priorities.

Activity 18: Climate Courtroom Trial

- **Target Age:** 14–18 years
- **Duration:** 70 Minutes
- **Materials:** Case brief files outlining environmental regulations and economic damages.
- **Procedure:** Organise a courtroom trial where an industrial logging firm is sued by a local youth group for clear-cutting a forest ecosystem that serves as a vital community carbon sink. Students serve as defence attorneys, prosecution teams, scientific expert witnesses, and jury members, using environmental laws and scientific data to argue their case.
- **Expected Outcomes:** Enhances argumentative logic, understanding of environmental law, and the value of public interest advocacy.

Activity 19: The Greenwashing Audit Board

- **Target Age:** 13–18 years
- **Duration:** 50 Minutes
- **Materials:** Samples of misleading eco-advertisements or product packaging.
- **Procedure:** Students act as compliance officers for an advertising standards agency. Teams review corporate advertisements that use vague environmental claims like “all-natural” or “net-zero carbon emissions.” They cross-examine the claims against lifecycle facts, decide whether the ad is guilty of greenwashing, and issue public correction orders.
- **Expected Outcomes:** Strengthens media literacy, critical analysis, and consumer awareness.

Activity 20: Fast Fashion vs. Circular Fashion Panel

- **Target Age:** 11–17 years
- **Duration:** 45 Minutes
- **Materials:** Fabric tags showing clothing material origins and production maps.
- **Procedure:** Students participate in a panel discussion tracking the lifecycle of a typical cotton t-shirt. Role-players represent a factory worker, a fast-fashion brand executive, a clothing thrift merchant, and a textile waste manager. They debate the environmental costs of clothing choices and pitch ways to transform the fashion market into a circular system.
- **Expected Outcomes:** Encourages students to reflect on their own wardrobe choices and consumer habits.

Category 5: Poster & Project

Activity 21: The Upcycled Art Exhibition

- **Target Age:** 6–18 years
- **Duration:** Long-term (Over 2 Weeks)
- **Materials:** Clean, non-hazardous discarded materials collected from the school campus (cardboard tubes, plastic caps, clean packaging sheets).
- **Procedure:** Students apply circular economy concepts to transform discarded campus waste items into creative, conceptual sculptures or mixed-media artworks. Each art piece is displayed with a student-written artist statement detailing the materials used, their environmental persistence rates, and the message behind the work.
- **Expected Outcomes:** Combines creative expression with hands-on material upcycling to raise awareness across the entire school.

Activity 22: Infographics for Energy Literacy

- **Target Age:** 10–16 years
- **Duration:** 60 Minutes

- **Materials:** Drawing paper, markers, or access to free digital graphic design tools.
- **Procedure:** Students convert complex climate statistics (such as regional grid configurations or global ice shelf melt rates) into clean, visual infographics. The finished designs are printed and posted above light switches, corridors, and communal spaces to encourage conservation habits.
- **Expected Outcomes:** Improves graphic design and data visualisation skills while communicating clear environmental information to the school community.

Activity 23: The School Waste Stream Mapping Project

- **Target Age:** 12–18 years
- **Duration:** 3 Class Sessions
- **Materials:** Large poster sheets, scales, safety gloves, and tracking clipboards.
- **Procedure:** Students conduct an audit of the school’s daily waste output. They weigh separate waste streams across classrooms, offices, and the cafeteria, cataloguing the percentage of recyclable and compostable items incorrectly sent to landfills. Teams build large visual charts to present their findings and recommend system changes to school leadership.
- **Expected Outcomes:** Empowers students to use data to drive real policy and system improvements within their school.

Activity 24: The Native Micro-Flora Herbarium

- **Target Age:** 8–15 years
- **Duration:** 2 Weeks
- **Materials:** Plant press frames, blank record books, and botanical field guides.
- **Procedure:** Students systematically collect fallen leaf and plant specimens from around the school campus. They press, dry, and mount them into a class catalogue book, logging the species name, ideal growing temperatures, and the specific ecological role the plant plays in supporting local urban wildlife.
- **Expected Outcomes:** Builds plant identification skills and connects students with the natural environment on campus.

Activity 25: Green Career Paths Wall Feature

- **Target Age:** 14–18 years
- **Duration:** 2 Class Sessions
- **Materials:** Research profiles of environmental careers, poster sheets, and craft supplies.
- **Procedure:** Students research emerging professional opportunities within the green economy, such as renewable energy grid engineers, eco-architects, and circular materials designers. They create an informational wall display mapping out the high school and university paths required to enter these sustainability-focused fields.

- **Expected Outcomes:** Aligns long-term educational goals with the skills needed for the future low-carbon economy.

Category 6: Challenges & Competitions

Activity 26: The Zero-Waste Lunchroom Challenge

- **Target Age:** 6–15 years
- **Duration:** 1 Week Challenge
- **Materials:** Waste scale trackers, sorting stations, and a shared daily progress scoreboard.
- **Procedure:** Grade levels compete to see who can produce the least single-use plastic and food waste during lunch over a five-day period. Students are encouraged to use reusable lunch containers, thermoses, and cloth napkins. Student leaders weigh the leftover landfill waste from each grade every day and log the scores publicly.
- **Expected Outcomes:** Uses friendly competition to quickly reduce school single-use plastic waste and change packing habits.

Activity 27: The Phantom Power Hunt

- **Target Age:** 9–16 years
- **Duration:** 3 Days
- **Materials:** Digital energy watt meters and simple classroom compliance checklists.
- **Procedure:** Student teams audit classrooms after hours to catch “phantom energy” drains, such as smart screens left on standby mode, idle chargers, or lights left on in empty rooms. Classrooms found fully powered down receive green star certifications, while teams track total electricity saved through their search.
- **Expected Outcomes:** Reduces passive electrical waste on campus and raises awareness about workplace conservation habits.

Activity 28: Eco-Escape Room Challenge

- **Target Age:** 11–18 years
- **Duration:** 45 Minutes
- **Materials:** Lockboxes, logic puzzles based on climate data, and cipher wheels.
- **Procedure:** Turn the classroom into a climate-themed escape room. To crack the lock combinations and “escape,” student teams must solve a series of logic puzzles: calculating a carbon footprint equation, correctly placing items on a waste hierarchy model, and tracing an ecosystem food chain link.
- **Expected Outcomes:** Promotes intense teamwork and requires quick, accurate recall of core environmental concepts under a time limit.

Activity 29: Upcycled Packaging Design Pitch

- **Target Age:** 13–18 years
- **Duration:** 90 Minutes

- **Materials:** Diverse clean trash streams and prototype assembly tape.
- **Procedure:** Student teams act as sustainable design firms tasked with replacing single-use plastic packaging for a common consumer product. They design and assemble a prototype using only compostable or upcycled waste materials, pitching their design to a panel of judges on its cost, functionality, and circular lifespan.
- **Expected Outcomes:** Sparks innovation and teaches the principles of sustainable eco-design and circular product lifecycles.

Activity 30: Community Climate Campaign Pitch

- **Target Age:** 14–18 years
- **Duration:** 3 Class Sessions
- **Materials:** Presentation software or poster materials.
- **Procedure:** Student teams design a practical public awareness campaign targeting an environmental issue in their local community, such as idling vehicles or low recycling participation. Teams pitch their campaign ideas to a panel of school and municipal leaders, with the winning plan selected for actual community rollout.
- **Expected Outcomes:** Connects classroom learning with active citizenship, empowering students to lead real environmental change in their neighborhoods.

CHAPTER 7: DIGITAL TOOLS FOR CLIMATE EDUCATION

This chapter highlights 15 professional digital tools carefully selected to enhance climate education through gamification, interactive data analysis, and creative collaboration. These platforms help teachers seamlessly bridge the gap between abstract climate science and engaging digital practice.

7.1 Digital Tools Matrix

1. Kahoot!

- **Short Description:** A game-based learning platform used to create and run interactive review quizzes.
- **Advantages:** Increases classroom engagement, offers instant feedback, and provides pre-made climate and sustainability quiz banks.
- **Subjects & Age:** All Subjects / Ages 6–18.
- **Difficulty:** Easy.

2. Canva

- **Short Description:** An intuitive graphic design platform packed with templates for visual media projects.
- **Advantages:** Perfect for building professional infographics, climate posters, and project presentations.
- **Subjects & Age:** Visual Arts, English, Geography / Ages 10–18.
- **Difficulty:** Easy to Medium.

3. Padlet

- **Short Description:** A digital collaborative bulletin board where students can share text, images, and links in real time.
- **Advantages:** Streamlines brainstorming sessions, resource curation, and peer-to-peer feedback on project ideas.
- **Subjects & Age:** All Subjects / Ages 8–18.
- **Difficulty:** Easy.

4. Mentimeter

- **Short Description:** An interactive presentation tool that captures live audience input through word clouds, polls, and open questions.
- **Advantages:** Excellent for checking initial student awareness, hosting debates, or gathering immediate feedback.
- **Subjects & Age:** Philosophy, History, Languages / Ages 11–18.
- **Difficulty:** Easy.

5. *Google Earth Engine*

- **Short Description:** A cloud-based platform for analysing planetary-scale geospatial datasets.
- **Advantages:** Allows students to view multi-decade time-lapse changes in forest cover, urban growth, and melting glaciers.
- **Subjects & Age:** Geography, ICT, Biology / Ages 14–18.
- **Difficulty:** Hard.

6. *PhET Interactive Simulations*

- **Short Description:** Interactive, research-based science and mathematics simulations developed by the University of Colorado Boulder.
- **Advantages:** Visually demonstrates invisible physical and chemical processes like the greenhouse effect and light absorption.
- **Subjects & Age:** Physics, Chemistry, Mathematics / Ages 12–18.
- **Difficulty:** Medium.

7. *CoSpaces Edu*

- **Short Description:** A 3D creation platform that lets students build and program their own virtual reality (VR) and augmented reality (AR) worlds.
- **Advantages:** Allows students to design and explore interactive virtual eco-cities or model working renewable energy grids.
- **Subjects & Age:** Computer Science, ICT, Technology / Ages 10–18.
- **Difficulty:** Medium to Hard.

8. *Wordwall*

- **Short Description:** A digital resource platform that converts vocabulary and core concepts into custom interactive games.
- **Advantages:** Quickly creates sorting games, match-ups, and mazes to reinforce sustainability terminology.
- **Subjects & Age:** Languages, Preschool, Primary School / Ages 5–14.
- **Difficulty:** Easy.

9. *Global Footprint Network Calculator*

- **Short Description:** An interactive online quiz that measures an individual's ecological and carbon footprint.
- **Advantages:** Translates daily habits into clear data, calculating how many Earths would be needed if everyone lived like the user.
- **Subjects & Age:** Mathematics, Geography, Guidance / Ages 10–18.
- **Difficulty:** Easy.

10. Book Creator

- **Short Description:** A simple digital publishing tool used to create interactive, multimedia ebooks.
- **Advantages:** Empowers students to author, design, and publish their own digital environmental handbooks or nature field logs.
- **Subjects & Age:** English, Turkish, Primary School / Ages 7–16.
- **Difficulty:** Easy.

11. Arduino / Micro:bit Simulator

- **Short Description:** Online code editors and simulators for microcontrollers that model hardware systems without needing physical boards.
- **Advantages:** Perfect for writing code to test smart automation setups, like automated watering triggers or light metres.
- **Subjects & Age:** Computer Science, Technology / Ages 12–18.
- **Difficulty:** Medium to Hard.

12. ThingLink

- **Short Description:** A digital tool used to overlay interactive hotspots (containing text, audio, video, or links) onto images and 360° virtual tours.
- **Advantages:** Allows teachers and students to create interactive diagrams of solar panels, waste facilities, or local ecosystems.
- **Subjects & Age:** Biology, Geography, ICT / Ages 11–18.
- **Difficulty:** Medium.

13. National Geographic MapMaker

- **Short Description:** An interactive map layering tool designed specifically for classroom exploration.
- **Advantages:** Helps students analyse relationships between population growth, land changes, and shifting climate indicators.
- **Subjects & Age:** Geography, History / Ages 9–16.
- **Difficulty:** Medium.

14. Genially

- **Short Description:** An online design application specialising in animated presentations, digital escape rooms, and interactive infographics.
- **Advantages:** Great for building gamified learning paths and interactive climate escape room challenges.
- **Subjects & Age:** All Subjects / Ages 10–18.
- **Difficulty:** Medium.

15. NASA Climate Time Machine

- **Short Description:** An interactive digital dashboard that visualises changing key climate indicators over time.
- **Advantages:** Gives students clear, reliable visual data on sea ice levels, global temperatures, carbon emissions, and sea level rise.
- **Subjects & Age:** Physics, Geography, Science / Ages 10–18.
- **Difficulty:** Easy.

CHAPTER 8: GOOD PRACTICES

This chapter presents good practices that show how to put climate education into practice. Section 8.2 describes proven models inspired by European programmes and initiatives (such as Eco-Schools, ESA Climate Detectives and Young Reporters for the Environment), with two models for each of the four main educational stages, focusing on clear objectives, simple setups and measurable outcomes. Sections 8.3 to 8.5 present the good practices developed and exchanged by our three partner schools during the Carbon Zero Through Education project, an overview of how they were transferred between the schools, and sample student reflections.

8.1 Good Practices Framework

Every model is organised around four clear criteria to support quick implementation:

- **Objectives:** The educational and ecological goals of the project.
- **Materials:** The basic resources and tools required.
- **Procedure:** Step-by-step actions for running the project successfully.
- **Expected Outcomes:** The structural and behavioural impacts on the school community.

8.2 Educational Stage Models

Stage 1: Preschool

Example 1: Tiny Forest Protectors (Eco-Schools Model)

- **Objectives:** To build a foundational respect for natural systems and develop early sorting and composting habits.
- **Materials:** Magnifying lenses, organic compost buckets, native seed packets, and colour-coded classroom recycling labels.
- **Procedure:** Children participate in daily outdoor discovery walks to log seasonal shifts, care for local plants, and collect clean organic scraps from their lunch boxes to feed the classroom compost bin.
- **Expected Outcomes:** Children independently sort their daily waste and show improved coordination and care for natural settings.

Example 2: The Plastic-Free Toy Workshop

- **Objectives:** To introduce basic concepts of the circular economy and creative material upcycling through play.
- **Materials:** Clean cardboard tubes, paper packaging scraps, washed plastic caps, and non-toxic water-based paints.

- **Procedure:** Children collect clean, safe household packaging waste and transform it into original toys, learning that materials can be reused rather than immediately discarded.
- **Expected Outcomes:** Reduces single-use classroom trash while building creative thinking and awareness about waste reduction.

Stage 2: Primary School

Example 3: The Classroom Phantom Power Hunt

See also Activity 27 for a classroom version for ages 9–16.

- **Objectives:** To introduce energy conservation through data tracking and build accountability for resource use.
- **Materials:** Simple tracking sheets, green star compliance stickers, and energy-monitoring dashboards.
- **Procedure:** Student teams take turns auditing classrooms at the end of the day, logging left-on displays or lights, and awarding green stars to workspaces that power down correctly.
- **Expected Outcomes:** Lowers the school building's electrical footprint while reinforcing daily energy-saving habits.

Example 4: The Zero-Waste Lunchroom Challenge

See also Activity 26 for the classroom version.

- **Objectives:** To minimise single-use packaging and food waste by using friendly group competition.
- **Materials:** Lunchroom weight scales, record sheets, and a public weekly progress scoreboard.
- **Procedure:** Grade levels compete over a week to produce the least amount of non-recyclable lunch trash by switching to reusable containers and cloth napkins.
- **Expected Outcomes:** A major decrease in single-use plastic waste alongside better sustainable packing habits at home.

Stage 3: Lower Secondary

Example 5: Climate Detectives (ESA Framework)

- **Objectives:** To use real scientific observation to track and analyse a localised environmental issue.
- **Materials:** Local weather data access, digital cameras, basic water testing kits, and internet-connected laptops.
- **Procedure:** Students investigate an environmental problem in their area (such as local microclimate changes or stream pollution), log findings, and pitch data-backed solutions to school leaders.
- **Expected Outcomes:** Improves data analysis and critical thinking skills, resulting in a formal local environmental report.

Example 6: The School Repair Café

See also Chapter 10, Project 4, for the school-wide version.

- **Objectives:** To apply circular economy principles by fixing broken items instead of replacing them.
- **Materials:** Basic tool kits, upcycled spare parts, work tables, and safety gear.
- **Procedure:** Guided by technical teachers, students set up a monthly workshop to fix broken classroom furniture, repair torn books, or restore school equipment.
- **Expected Outcomes:** Extends the useful life of school property, cuts down on waste, and builds valuable hands-on technical skills.

Stage 4: Upper Secondary

Example 7: Young Reporters for the Environment (YRE)

- **Objectives:** To build environmental journalism, media analysis, and communication skills focused on local sustainability.
- **Materials:** Digital video cameras, voice recorders, and basic media layout or editing tools.
- **Procedure:** Students research complex climate issues in their municipality, interview experts and local leaders, and publish articles or produce video documentaries to suggest policy changes.
- **Expected Outcomes:** Develops advanced research and communication skills, increasing community awareness through student journalism.

Example 8: The Smart Grid Eco-Design Pitch

- **Objectives:** To design and prototype engineering solutions that optimise resource distribution and support green tech.
- **Materials:** Programmable microcontrollers (micro:bits), moisture or light sensors, solar panel test units, and presentation tools.
- **Procedure:** Student teams design automated, high-efficiency building systems—such as smart lighting grids or water-saving irrigation setups—and pitch their designs to a panel of experts.
- **Expected Outcomes:** Combines engineering and tech skills to produce functional models that improve energy and water efficiency.

8.3 Good Practices from Our Partnership

The following examples were developed, tested or exchanged by the three partner schools during the Carbon Zero Through Education project. They show how an idea from one school can be adapted by another, according to regional needs, school structures and financial possibilities.

Example 9: The Year 9 Project “Energy and Sustainability” (Gymnasium Vogelsang, Solingen)

- **Background:** The interdisciplinary project “Energy and Sustainability” was first carried out at Gymnasium Vogelsang in 2009 and has taken place every year since then in Year 9, in the subjects biology, chemistry, physics, and economics and politics.
- **Organisation:** For four weeks in January and February, the four weekly lessons of these subjects and two additional (half-)days are turned into project time. The teachers of the participating subjects plan and supervise the project together.
- **Objectives:** Students choose a focus from the wide field of renewable energy and present their specialist knowledge, the ways in which this knowledge is gained, and their own evaluation. This includes the technical and scientific side as well as the social, economic and political dimensions. Energy sources and technologies are examined critically, with their advantages and disadvantages.
- **Topics:** Students choose from twelve topics, for example “*The Greenhouse Earth Is Getting Too Warm*” or “*Biofuels – Green Gold or Food First?*”.
- **First Highlight, the Lab Day:** Students carry out a series of experiments on their topic and evaluate them.
- **Second Highlight, the Poster Walk:** The results are presented as posters in a Poster Walk, and the presentation is graded. The posters can be viewed by all students of the school.
- **Competences:** The Lab Day and the Poster Walk in particular are major challenges in terms of self-organisation, communication, teamwork and presentation skills. By mastering these challenges, students develop a deeper understanding of their own abilities and of the importance of their contribution to the work process.
- **Aims:** The project prepares students for the challenges of a globalised world and motivates and enables them to work actively towards the goals of sustainable development. In this way, it contributes to a responsible, future-oriented generation.
- **In the Erasmus+ Project:** On the first day of the learning activity in Solingen, the project coordinator, a physics teacher, presented the concept and hands-on experiments from the project in a Poster Walk. The students’ posters attracted particular interest from the two chemistry teachers of the Italian group. The visit to the Garzweiler lignite mine in the Rhineland and the visits to a biogas plant, geothermal plants and solar-powered ceramics factories in and around Tavşanlı provided further real-life examples.
- **Transfer:** Our partner schools in Türkiye and Italy have taken up parts of the concept, or ideas from it, in their lessons and are considering integrating them permanently into their curricula. The project can be adapted easily: as shorter project days, with fewer topics, or with a focus on the energy issues most relevant in the school’s own region.

Example 10: The Blue Forest: Reforestation Adapted to Regional Needs (Solingen)

- **Objectives:** Students understand forests as carbon sinks and habitats, and actively contribute to reforestation in their own region.

- **Background:** The “Blue Forest” (*Blauer Wald*) in Solingen-Gräfrath is a reforestation project co-financed by the state of North Rhine-Westphalia, in which Gymnasium Vogelsang takes part. During the first learning activity (15–19 September 2025), students from Germany, Türkiye and Italy planted trees there together. The campaign was reported on by the regional broadcaster WDR and became one of the strongest symbols of our project.
- **Procedure for Biology and Geography:** Students analyse the condition of local forests (e.g., drought and pest damage), research climate-resilient native tree species, contact local forestry offices or environmental agencies, and plan a planting campaign including long-term care (watering, maintenance by a student group).
- **Adaptation:** Every school adapts the idea to its regional needs and financial possibilities: a forest plot in cooperation with the municipality, a few trees on the school grounds, a hedge for biodiversity, or tree sponsorships. What matters is that students experience climate protection as something they can do with their own hands.
- **Expected Outcomes:** A lasting carbon sink, more biodiversity, and a strong connection between students and their local environment.

Example 11: The Annual Plogging Day (Senigallia → Solingen)

- **Objectives:** To combine sport, environmental action and community spirit.
- **Background:** Plogging (jogging + picking up litter) is an established part of sustainability education at our Italian partner school in Senigallia. Inspired by this example, Gymnasium Vogelsang held its first Plogging Day in July 2026 with 120 upper-secondary students.
- **Procedure:** Teams jog through the school grounds and the surrounding neighbourhood, collect and sort litter, and document distances and quantities. The kilometres run are added to the symbolic “We Run to Our Partner Schools” challenge (see Chapter 4, 13. Physical Education, and Lesson Plan 11).
- **Sustainability:** The Plogging Day now takes place every year at the end of the German school year at Gymnasium Vogelsang. It is a lasting result of the project and a clear example of good practice travelling from one partner school to another.

Example 12: Renewable Energy in Practice (Tavşanlı)

- **Objectives:** To link the theory of renewable energy with real-life applications.
- **Procedure:** Participants visited renewable energy facilities in and around Tavşanlı: the Yılmazlar Farm, a biogas facility where cow manure is turned into biogas and then into energy; geothermal plants; and ceramics factories supplied with solar energy. At each facility, engineers guided the group and explained how the technology works, from geothermal heat and methane from biogas to solar power. At the Future Center near Kütahya, Turkish scientists presented national and international efforts to promote renewable energy and explained why it is essential compared with conventional fossil energy sources. During a classroom visit, students compared renewable energy in Türkiye, Germany and Italy with the help of practical examples.
- **Classroom Transfer:** Physics and chemistry lessons can use local renewable energy facilities and research centres as places of learning. Students prepare questions in

advance, collect data during the visit and evaluate it afterwards (see Chapter 4, 2. Physics and 3. Chemistry).

Example 13: Circular Fashion, Upcycling and Art for Peace (Senigallia)

- **Objectives:** To make the circular economy visible and creative.
- **Procedure:** In workshops, students presented outfits made from upcycled materials, and chemistry lab students calculated the energy needed to produce a pair of jeans. Together with a local group of artists, students from three countries painted a large mural with messages of peace in languages from all continents on the sports hall of the partner school. Instead of the originally planned visit to a recycling centre, the group visited a local sustainability club, where young people develop and support sustainable, locally rooted projects; in several seminars there, participants learnt how to recycle and upcycle things in everyday life. In workshops at the host school, students made buttons, bags and jewellery from waste materials, and they presented and compared the recycling systems of their countries.
- **Classroom Transfer:** Combine Activity 20 (Fast Fashion vs. Circular Fashion Panel) with an upcycling workshop; use a wall, fence or panel at school for a collaborative climate or peace mural (see Chapter 4, 11. Visual Arts).

Example 14: Students as Climate Ambassadors

- **Objectives:** To give students a public voice and to share the project's results beyond the school.
- **Procedure:** At the end of the project, students of Gymnasium Vogelsang presented Carbon Zero Through Education at the Bergisches Entwicklungsforum "Global vereint vor Ort!" in Solingen, together with organisations and initiatives from the region. They spoke about the Blue Forest, recycling in Italy, renewable energy in Türkiye and the importance of international cooperation. Media reports in all three countries (e.g., WDR Lokalzeit Bergisches Land, Turkish regional media and the local press in Senigallia) further raised awareness.
- **Classroom Transfer:** Students prepare short talks, posters or social media posts on their projects and present them to parents, local politicians or regional networks (see Activity 30 and Example 7).

8.4 Transfer Between the Partner Schools

Good practice	Origin	Transfer
Plogging Day	Senigallia (Italy)	Adopted by Gymnasium Vogelsang as an annual event at the end of the school year
Year 9 project "Energy and Sustainability"	Solingen (Germany)	Partner schools in Türkiye and Italy have taken up parts or ideas in their lessons and are considering integrating them into their curricula
Blue Forest reforestation	Solingen (Germany)	Model for reforestation in biology and geography lessons, adapted to regional needs and budgets

Good practice	Origin	Transfer
Renewable energy site visits	Tavşanlı (Türkiye)	Model for using local energy facilities as places of learning
Upcycling, circular fashion and murals	Senigallia (Italy)	Model for art, technology and chemistry lessons
Furniture from recycled waste	Senigallia (Italy)	Adopted by Gymnasium Vogelsang and put into practice on action days
Cycling reward app	Tavşanlı (Türkiye)	Idea in progress at Gymnasium Vogelsang; to be developed with the computer science department
This handbook	All three schools	Written jointly by teachers of all three partner schools under the coordination of Gymnasium Vogelsang; final version compiled by Gymnasium Vogelsang with the agreement of all partners

8.5 Student Voices: Sample Reflections

Reflection is an important part of every activity in this handbook. **The following texts are not authentic student contributions.** They are sample reflections written for this handbook, based on the kind of statements students made during the project activities. Teachers can use them in class as model reflections, or as prompts that students adapt in their own words, for example as an exit ticket or a portfolio entry (see Chapter 9).

“Before the project, I thought biofuels were simply ‘green’. After our experiments on the Lab Day and our research on ‘Green Gold or Food First?’, I understood that every energy source has advantages and problems. Explaining our poster to others at the Poster Walk was hard at first, but I was proud in the end.”

Sample reflection, inspired by the Year 9 project “Energy and Sustainability” (Solingen)

“At the biogas farm I was surprised that cow manure can produce electricity. In our region there are many farms. Why don’t more of them do this?”

Sample reflection, inspired by the visit to the Yılmazlar biogas farm (Tavşanlı)

“Painting the mural with students from Germany and Türkiye was the best part. We did not always speak the same language, but we had the same idea: peace and a healthy planet.”

Sample reflection, inspired by the mural project (Senigallia)

“At first plogging sounded strange. After one hour our bags were full, and people in the street thanked us. I want to do it again next year.”

Sample reflection, inspired by the Plogging Day (Solingen)

CHAPTER 9: ASSESSMENT AND EVALUATION

Assessment in climate education goes beyond testing memorised scientific facts. It evaluates changes in environmental behaviour, the development of critical thinking, and the practical application of sustainability skills. This chapter outlines key assessment tools that make environmental education measurable and professional.

Note: A structured lesson planning template that includes formative assessment is provided in Chapter 11.2.

9.1 Formative and Observational Assessment

- **Teacher Observation:** Informal, continuous monitoring of student engagement, collaboration, and problem-solving during hands-on STEM activities or debates.
- **Exit Tickets:** Quick, end-of-lesson formative checks where students write down one core concept they learned (e.g., “Define circular economy”) or one remaining question before leaving the classroom.
- **Environmental Behaviour Checklist:** A practical tracking tool used to monitor whether students are adopting sustainable habits over time, such as properly sorting waste, turning off lights, or reducing single-use plastics.

9.2 Student-Centred Assessment

- **Student Self Assessment:** Tools that encourage learners to reflect on their own environmental habits, learning progress, and personal carbon footprints, fostering personal accountability.
- **Peer Assessment:** Structured evaluations where students review and provide constructive feedback on their classmates’ presentations, group work, or upcycled art projects.
- **Reflection Questions:** Open-ended prompts designed to assess deep understanding, ethical reasoning, and emotional connection to climate issues (e.g., “How does our local climate action affect the global community?”).

9.3 Summative and Performance Assessment

- **Rubrics:** Clear, standardised grading grids used to evaluate complex assignments like persuasive speeches, circular business plans, or mock UN climate resolutions based on specific criteria.
- **Portfolio:** A curated collection of a student’s work over the semester—including lab reports, creative writing, and data maps—demonstrating their long-term growth in climate literacy.
- **Performance Assessment:** Evaluating students based on their ability to execute practical, real-world tasks, such as successfully building an insulated architectural model or coding an energy-saving algorithm.

- **Project Evaluation:** Comprehensive assessments of long-term group initiatives (like the Zero-Waste Lunchroom Challenge), focusing on research depth, execution, teamwork, and actual environmental impact.

9.4 Measuring Impact at Project Level

The Carbon Zero Through Education project also evaluated its own impact. Schools that run similar projects can use the same approach:

- **Pre- and Post-Survey:** An international online survey on everyday climate-related habits (mobility, energy, food, waste and consumption), carried out in all three countries before and at the start of the learning activities (August–September 2025, 451 participants) and again after the end of the project (from September 2026, 608 participants: students, families and school staff).
- **What the Survey Showed:** Energy-saving routines are already widespread: after the project, 96% of respondents switched off unused devices, 94% ran full appliance loads and 88% paid attention to saving water. The biggest challenges remain long-distance public transport (50%), environmentally friendly clothing (54%) and food leftovers, which 41% still throw away. Younger respondents reported fewer climate-friendly habits than adults. Many activities in this handbook address exactly these topics, e.g., Bike Day, Swap Market and Repair Café in Chapter 10.
- **Lessons for Evaluation:** A reliable before-and-after comparison was not possible: most individual pre-test responses were lost during data export, and the two survey groups differed considerably in age and country. Schools adopting this approach should store raw data safely, use identical questionnaires in all languages and give participants an anonymous code, so that the same people can be compared before and after.
- **Regular Transnational Project Meetings:** Online meetings of the coordinators and staff of all partner schools, documented in a shared online archive, to plan, review and give feedback on every activity.
- **Certificates of Participation:** Issued to participants after each learning activity.
- **Closing Climate Conference:** A video conference in August 2026 with around 40 participants from all three countries discussed how the EU's climate neutrality target is reflected in the partners' curricula and how it could be strengthened.
- **Curriculum Transfer:** Selected student outputs and good practices (see Chapter 8.3) are taken up in the curricula of the partner schools.

CHAPTER 10: SCHOOL-WIDE SUSTAINABILITY PROJECTS

School-wide projects bring climate education out of individual classrooms and embed sustainability directly into the daily life and culture of the entire school. These collaborative initiatives involve students, teachers, and administrative staff working together to turn the school into a living laboratory for low-carbon living.

10.1 Structured Event Outlines

Project 1: Carbon Free Week

- **Description:** A dedicated five-day campaign where the school community actively reduces its collective carbon footprint.
- **Key Activities:** Implementing digital-only teaching days to eliminate paper waste, organising carpools, and running a “no plug” hour where classrooms rely strictly on natural daylight and non-digital teaching methods.
- **Impact:** Drastically reduces weekly energy usage and builds direct awareness of hidden institutional emissions.

Project 2: Green Day

- **Description:** An annual celebration dedicated to environmental action, biodiversity awareness, and campus greening.
- **Key Activities:** Hosting guest speakers on renewable energy, holding upcycled clothing or art exhibitions, and holding hands-on workshops where students build micro-composting systems.
- **Impact:** Connects the entire student body through shared ecological goals and values.

Project 3: Bike Day

- **Description:** A community-wide initiative celebrating low-carbon active transportation.
- **Key Activities:** Encouraging all students and staff to bicycle, skate, or walk to campus instead of using cars; setting up bicycle safety training tracks; and calculating the total emissions avoided by the school community on that day.
- **Impact:** Promotes physical fitness while demonstrating practical alternatives to fossil-fuel commutes.

Project 4: Repair Café

See also Chapter 8.2, Example 6.

- **Description:** A community workspace that directly counters traditional linear consumption habits by prioritising repair over disposal.
- **Key Activities:** Technical students, teachers, and community volunteers set up repair stations to fix broken school electronics, loose furniture legs, torn books, and damaged sports equipment.

- **Impact:** Keeps high-value items out of landfills while teaching students essential engineering and circular economy skills.

Project 5: Swap Market

- **Description:** A student-led resource exchange bazaar built entirely on circular economy principles.
- **Key Activities:** Students bring in clean, gently used textbooks, revision guides, outgrown clothing, and school supplies to trade freely with their peers using a non-monetary token system.
- **Impact:** Maximises resource reuse and explicitly reduces the consumption footprint of purchasing brand-new consumer goods.

Project 6: Eco Fair

- **Description:** A public showcase where student teams present original sustainability designs, research projects, and eco-enterprises to parents and local businesses.
- **Key Activities:** Demonstrating home-built solar cookers, pitching circular business canvas ideas, selling student-grown organic vegetables, and distributing environmental literacy brochures.
- **Impact:** Builds professional green skills, public speaking confidence, and civic environmental pride.

Project 7: Tree Planting

- **Description:** A hands-on ecosystem restoration campaign to offset school carbon emissions and enrich local biodiversity.
- **Key Activities:** Coordinating with regional environmental agencies to clear soil, plant native tree saplings on or around campus grounds, and setting up a student-led maintenance group for long-term watering and care.
- **Impact:** Creates a permanent carbon sink on campus, reduces local heat island effects, and supports native wildlife.
- **Project Link:** See the Blue Forest in Solingen-Gräfrath (Chapter 8.3, Example 10).

Project 8: Plastic Free Week

- **Description:** A strict one-week challenge focused on completely eliminating single-use plastics from the school environment.
- **Key Activities:** Banning single-use plastic water bottles and snack packaging from the cafeteria; challenging students to pack entirely zero-waste lunches using reusable containers; and running plastic collection audits to track progress.
- **Impact:** Promotes immediate behavioural shifts and challenges corporate packaging reliance across families and campus supply lines.

Project 9: Annual Plogging Day

- **Description:** A school-wide sports and environmental event at the end of the school year, in which students jog in teams and collect litter in the school's neighbourhood. At Gymnasium Vogelsang it was held for the first time in July 2026 and now takes place every year, inspired by our partner school in Senigallia.

- **Key Activities:** Planning safe routes with the municipality and the local waste management service; team runs with collection bags; sorting and weighing the litter; adding the kilometres to the “We Run to Our Partner Schools” counter; presenting the results on the school website and social media.
- **Impact:** A visibly cleaner neighbourhood, a strong sense of community at the end of the school year, and a lasting link between physical activity and climate protection.

Project 10: Furniture from Waste

- **Description:** An art and technology project in which students design and build functional furniture from collected and recycled waste materials. The idea comes from our Italian partner school in Senigallia; at Gymnasium Vogelsang it is now put into practice on action days.
- **Key Activities:** Collecting suitable materials (pallets, crates, tyres, wooden offcuts, textile scraps); designing pieces in art lessons; building them safely with technology teachers; furnishing a “recycled furniture store” exhibition, a classroom reading corner or the schoolyard.
- **Impact:** Turns waste into lasting, useful objects, makes the circular economy tangible, and promotes creativity and practical skills.

Project 11: “We Run to Our Partner Schools”

- **Description:** A long-term, school-wide challenge in which every kilometre run or cycled by students is added to a symbolic journey between Solingen, Senigallia and Tavşanlı (about 4,540 km for the full circuit).
- **Key Activities:** Logging distances from PE lessons, the Plogging Day and active school journeys; a progress map in the school hallway; regular updates exchanged with the partner schools.
- **Impact:** Keeps the partnership visible in everyday school life and motivates students to move more and drive less.

CHAPTER 11: INTERACTIVE TOOLS AND LESSON INTEGRATION

To ensure that the green skills, activities, and digital tools detailed in this handbook translate into actionable learning, climate education must be systematically embedded into the weekly school curriculum. This chapter outlines how teachers can integrate sustainability themes across various academic disciplines and provides an interactive framework for lesson planning.

11.1 Cross-Curricular Integration Paths

Climate literacy is inherently interdisciplinary. Rather than treating sustainability as a standalone subject, educators can weave it into existing core curricula:

- **Language and Literature:** Students analyse persuasive texts on environmental issues, write essays on ecological transformation, or practice vocabulary through global sustainability debates. Foreign language lessons compare how other countries tackle climate change, and lessons in the language of schooling analyse the current climate debate in newspapers and literature (Lesson Plans 12 and 13).
- **Mathematics and Statistics:** Learners analyse real-world datasets, calculate personal or school carbon footprints, and interpret graphs tracking global temperature shifts over time.
- **Natural Sciences (Physics, Chemistry, Biology):** Labs focus on the chemical reactions of greenhouse gases, the engineering behind photovoltaic cells, or field surveys mapping local biodiversity loss.
- **Social Studies and Geography:** Lessons explore the geopolitical impact of resource scarcity, urban heat islands, and the socioeconomic structures of a circular economy versus a linear one.
- **Physical Education:** Plogging, active transport and the “We Run to Our Partner Schools” challenge link sport with climate protection and with physics (Lesson Plan 11).
- **Arts and Technology:** Murals, upcycled fashion and furniture made from waste make the circular economy visible (Chapter 10, Project 10).

11.2 Interactive Lesson Planning Template

Teachers can utilise the following structured template to design cohesive, action-oriented climate lessons that balance digital tool usage with active classroom challenges.

Lesson Component	Description & Teacher Action
1. Hook / Icebreaker	A 5–10 minute introductory activity (e.g., <i>The Carbon Web</i> or a live <i>Mentimeter</i> poll) to activate prior knowledge and spark immediate student interest.
2. Core Content Delivery	Introducing the scientific concept, green skill, or circular economy principle using interactive media

Lesson Component	Description & Teacher Action
	or digital simulations (e.g., <i>PhET Interactive Simulations</i>).
3. Collaborative Challenge	Transitioning students into small teams to complete a practical, hands-on task, experiment, or role-play scenario (e.g., <i>Upcycled Packaging Design Pitch</i>).
4. Digital Reflection	Using a collaborative platform (e.g., <i>Padlet</i> or <i>Canva</i>) for students to log their findings, design infographics, or share group project outcomes.
5. Formative Assessment	Closing the lesson with a quick check for understanding, such as an online review game or an open-ended reflection question acting as an <i>Exit Ticket</i> .

11.3 Action Plan for School-Wide Adoption

To achieve a successful, comprehensive transition toward a green campus culture, the school management and teaching staff are encouraged to follow a phased implementation timeline:

1. **Phase 1: Curriculum Mapping (Weeks 1–4):** Departments meet to align specific handbook activities and digital tools with their upcoming term learning objectives.
2. **Phase 2: Pilot Implementations (Weeks 5–8):** Teachers run selected classroom challenges and utilise targeted formative assessment checklists to monitor initial student behavioural shifts.
3. **Phase 3: School-Wide Campaign (Month 3 onward):** Transitioning from individual classroom activities to macro-level events, such as launching a *Zero-Waste Lunchroom Challenge* or a campus *Repair Café*.

CHAPTER 12: RESOURCES AND USEFUL LINKS

To support teachers in implementing the activities, digital tools, and projects outlined in this handbook, this chapter provides a curated collection of high-quality, open-access resources and international networks.

12.1 International Educational Frameworks & Platforms

- **eTwinning Portal:** An online community for schools in Europe to collaborate on joint projects, share pedagogical practices, and run international classroom initiatives. Our partner school in Senigallia used eTwinning to present the project and its results to a network of ten schools. <https://school-education.ec.europa.eu/en/etwinning>
- **Eco-Schools Global:** The world's largest sustainable schools programme, offering structured frameworks, green flag certification guidelines, and environmental audit templates. <https://www.ecoschools.global>
- **Young Reporters for the Environment (YRE):** An international network providing training resources, competition guidelines, and platforms for youth-led environmental journalism. <https://www.yre.global>
- **European Space Agency (ESA) Climate Detectives:** An educational initiative offering classroom resources, satellite data access, and teacher guides for tracking local climate issues. <https://climatedetectives.esa.int>

12.2 Digital Simulations & Data Dashboards

- **PhET Interactive Simulations:** Open-access physics and chemistry simulations from the University of Colorado Boulder, ideal for modelling the greenhouse effect and solar energy mechanics. <https://phet.colorado.edu>
- **NASA Climate Time Machine:** An interactive visual dashboard tracking key global climate indicators, including sea ice melt, carbon emissions, and sea-level rise over time.
- **Global Footprint Network Calculator:** A user-friendly online tool for calculating personal, classroom, or institutional ecological footprints. <https://www.footprintcalculator.org>
- **Google Earth Engine:** A powerful platform for analysing historical satellite imagery to visualise deforestation, urban heat islands, and landscape changes. <https://earthengine.google.com>

12.3 Open-Source Teaching Materials & Tools

- **UNESCO Climate Change Education Resources:** A comprehensive library of free lesson plans, pedagogical guides, and policy frameworks for sustainable development. <https://www.unesco.org/en/climate-change/education>
- **Canva for Education:** Free design templates specifically tailored for students to create climate infographics, awareness posters, and campaign presentations. <https://www.canva.com/education>

- **Genially & Padlet Resource Hubs** (<https://genially.com>, <https://padlet.com>): Pre-made templates for environmental interactive breakout rooms, digital escape games, and collaborative classroom brainstorming boards.

12.4 European Climate Policy and Country Information

- **EU Climate Action Portal (European Commission):** Information on the European Green Deal, the European Climate Law (climate neutrality by 2050) and the 2030 targets; useful for comparing EU member states in foreign language and social studies lessons. <https://climate.ec.europa.eu>
- **Climate Action Tracker:** Independent country assessments of climate targets and policies, including Germany, the EU and Türkiye. <https://climateactiontracker.org>
- **ADEME (Agence de la transition écologique):** French public agency with accessible materials on energy, waste and climate, suitable for French lessons. <https://www.ademe.fr>

12.5 Project Results

- **Erasmus+ Project Results Platform:** A report on Carbon Zero Through Education with its most important results, linked to the project logo and homepage. <https://erasmus-plus.ec.europa.eu/projects>
- **Project Homepage “Carbon Zero Through Education”:** <https://www.carbon-zero-through-education.com>
- **School Websites and Social Media:** Gymnasium Vogelsang Solingen, Tavşanlı 15 Temmuz Şehitler Science High School and Polo Tecnico Professionale Corinaldesi Padovano share project news on their websites and their Instagram and Facebook profiles.

GLOSSARY

1. **Active Citizenship:** Engaging in community and civic actions to solve localised or global environmental challenges.
2. **Active Learning:** A teaching method that directly involves students in the learning process through activities, discussions, and prototypes.
3. **Active Transportation:** Human-powered travel, such as walking, cycling, or skating, that emits zero greenhouse gases.
4. **Adaptability:** (1) The capacity of an ecosystem or social system to adjust to climate change in order to minimise potential damage. (2) In GreenComp, a sustainability competence: the ability of learners to manage transitions and challenges in complex sustainability situations and to make decisions despite uncertainty.
5. **Aerodynamics:** The study of how gases interact with moving bodies, applied in optimising wind turbine blade designs.
6. **Afforestation:** The act of establishing a forest on land that has not recently been covered by trees, creating new carbon sinks.
7. **Agroecology:** Sustainable farming practices that work with nature, enhancing biodiversity and soil health.
8. **Algorithmic Efficiency:** Optimising code to reduce computing power, which in turn lowers data centre energy consumption.
9. **Alternative Energy:** Energy sources derived from non-fossil fuel origins, designed to reduce carbon emissions.
10. **Anthropogenic Emissions:** Greenhouse gases released into the atmosphere as a direct result of human activities.
11. **Atmospheric Pressure:** The force exerted by the weight of the air, affecting global and local weather patterns.
12. **Automated Irrigation:** Technology-driven watering systems that use sensors to conserve water by watering only when necessary.
13. **Behavioural Shift:** A conscious change in personal or institutional habits to reduce environmental impact.
14. **Biodegradable Material:** Matter capable of being decomposed naturally by bacteria or other living organisms without leaving toxins.
15. **Biodiversity:** The variety of all living organisms within a specific ecosystem, region, or across the entire planet.
16. **Bioenergy:** Renewable energy produced from biological sources, such as organic waste or sustainable biomass.

17. **Biogas:** A renewable gas, mainly methane, produced when organic material such as manure or food waste is broken down by bacteria without oxygen; it can be burned to generate heat and electricity.
18. **Biomimicry:** The practice of mimicking nature's designs and processes to solve human engineering and design challenges.
19. **Biosphere:** The global ecological system integrating all living beings and their relationships.
20. **Boron:** A chemical element used as a dopant in silicon to create the positively doped (p-type) layer of most conventional solar cells, which is essential for generating electric current.
21. **Carbon Cycle:** The natural process by which carbon atoms continuously travel from the atmosphere to the Earth and then back.
22. **Carbon Footprint:** The total amount of greenhouse gases generated by our actions, typically expressed in tons of CO₂ equivalent.
23. **Carbon Mitigation:** Strategies and actions designed to reduce or prevent the emission of greenhouse gases.
24. **Carbon Sink:** A natural or artificial reservoir, such as a forest or ocean, that absorbs and stores more carbon dioxide than it releases.
25. **Checklist Assessment:** A performance-tracking tool used to monitor student habits and criteria-based compliance over time.
26. **Circular Economy:** An economic system focused on eliminating waste through continuous recycling, repair, and upcycling of materials.
27. **Climate Adaptation:** Adjusting ecological, social, or economic systems in response to actual or expected climatic stimuli.
28. **Climate Change:** Long-term shifts in temperatures and weather patterns, primarily driven by human activities like burning fossil fuels.
29. **Climate Literacy:** An understanding of human influence on climate and climate's influence on humans and society.
30. **Climate Neutrality:** A state in which human activities result in no net effect on the climate system, because remaining emissions are balanced by removals; the EU aims to reach it by 2050.
31. **Composting:** The natural process of recycling organic matter, such as food scraps, into a rich fertiliser for soil.
32. **Conservation:** The responsible management and protection of natural resources and ecosystems to prevent destruction.
33. **Consumer Awareness:** Understanding the ecological and social impacts of products before purchasing them.

34. **Cross-Curricular Path:** An educational strategy that integrates sustainability themes across multiple traditional academic subjects.
35. **Deforestation:** The purposeful clearing of forested lands, which reduces global carbon sink capacity.
36. **Digital Tools:** Software, platforms, and digital applications used to enhance interactivity and visualisation in education.
37. **Eco-Design:** Designing products with their entire lifecycle footprint in mind to maximise durability and recycling potential.
38. **Ecological Footprint:** A measure of human demand on Earth's ecosystems, comparing resource consumption to nature's capacity to regenerate.
39. **Ecosystem:** A biological community of interacting organisms and their physical environment.
40. **Energy Efficiency:** Using less energy to perform the same task or achieve the same operational output.
41. **Environmental Law:** The collective body of legal rules, treaties, and regulations protecting the environment from damage.
42. **European Climate Law:** Regulation (EU) 2021/1119, which makes the EU's goal of climate neutrality by 2050 legally binding and sets an interim target of at least 55% net emission reduction by 2030 compared with 1990.
43. **European Green Deal:** The European Commission's strategy, presented in 2019, to make the EU climate-neutral by 2050 while promoting a sustainable economy.
44. **Exit Ticket:** A quick, formative assessment method used at the end of a lesson to gauge immediate comprehension.
45. **Fast Fashion:** Rapid production of inexpensive clothing, resulting in high water consumption and massive textile waste.
46. **Formative Assessment:** Continuous, low-stakes evaluations used by teachers to monitor student learning and guide instruction.
47. **Fossil Fuels:** Natural carbon-based fuel sources, such as coal, oil, and natural gas, formed from prehistoric organisms.
48. **Geospatial Data:** Information that identifies the geographic location and features of planetary structures over time.
49. **Global Warming:** The long-term heating of Earth's climate system observed since the pre-industrial period due to human activities.
50. **Green Career:** Employment opportunities in industries that directly contribute to preserving or restoring environmental quality.
51. **Green Skills:** The technical knowledge, values, and abilities needed to develop and support a sustainable, resource-efficient society.

52. **Greenhouse Effect:** The trapping of the sun's warmth in a planet's lower atmosphere due to the accumulation of specific gases.
53. **Greenwashing:** Conveying a false or misleading impression about how a company's products are environmentally sound.
54. **Habitat Fragmentation:** The emergence of discontinuities in an organism's preferred environment, impacting local biodiversity.
55. **Infographic:** A visual representation of information, data, or statistics designed to make complex data easy to understand.
56. **Interdisciplinary:** An approach that combines two or more academic disciplines into a single integrated learning activity.
57. **Lifecycle Thinking:** Assessing the environmental impacts of a product from raw material extraction all the way to final disposal.
58. **Lignite:** Brown coal; a low-grade fossil fuel with particularly high CO₂ emissions per unit of energy, mined in open pits such as Garzweiler in Germany.
59. **Linear Economy:** A traditional "take-make-waste" industrial model where resources are extracted, used, and thrown away.
60. **Microplastics:** Tiny plastic particles less than 5 millimetres in diameter that pollute marine and terrestrial ecosystems.
61. **Mitigation:** Actions taken to reduce the severity or progress of climate change, particularly by cutting emissions.
62. **Net-Zero Emissions:** Achieving a balance between the greenhouse gases put into the atmosphere and those taken out.
63. **Open-Access:** Free, unrestricted online access to educational resources, research materials, and digital platforms.
64. **Phantom Power:** Electricity consumed by electronic appliances while they are switched off or on standby mode.
65. **Photovoltaic Cell:** An electronic component that captures solar radiation and converts it directly into electrical energy.
66. **Plogging:** A combination of jogging and picking up litter (from the Swedish *jogga* and *plocka upp*); popular as a sports and environmental activity in schools.
67. **Project-Based Learning:** A student-centred pedagogy where students gain knowledge by working on long-term, real-world projects.
68. **Recycling:** The process of converting waste materials into new materials and objects to reduce resource extraction.
69. **Reforestation:** Replanting trees in areas where forests have been lost or damaged, for example by drought, storms or pests.

- 70. **Renewable Energy:** Energy from sources that naturally replenish themselves in a short period, such as sunlight and wind.
- 71. **Resource Management:** The efficient and sustainable deployment of an institution's resources when and where they are needed.
- 72. **Rubric:** A scoring guide used to evaluate performance or project quality based on a full range of explicit criteria.
- 73. **Single-Use Plastic:** Disposable plastics intended to be used only once before they are thrown away or recycled.
- 74. **Smart Grid:** An electricity network that uses digital automation to monitor and manage the transport of electricity efficiently.
- 75. **Summative Assessment:** High-stakes evaluations used to measure student learning at the conclusion of an instructional unit.
- 76. **Sustainability:** Meeting the needs of the present without compromising the ability of future generations to meet their own needs.
- 77. **Tragedy of the Commons:** An economic problem where individuals neglect the well-being of society in the pursuit of personal gain.
- 78. **Upcycling:** Creative reuse of discarded materials or waste items to create a product of higher quality or value than the original.
- 79. **Urban Heat Island:** An urban area that is significantly warmer than its surrounding rural areas due to human activities and dark infrastructure.
- 80. **Waste Stream:** The complete flow of waste from its domestic or industrial source through to recovery, recycling, or final disposal.

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