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INTEGRATED EXPLORATION: CREATIVE THINKING AND SUSTAINABLE SOLUTIONS

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Small-scale partnerships in school education (KA210-SCH)



MODULE 3

Sustainability and Environmental Science

Digital Content Guide · Student & Teacher Edition

5 Detailed Lesson Plans

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How to Use This Guide

Module 3 is designed to empower students as agents of change — not to overwhelm them with the scale of environmental problems. Every session balances an honest look at a challenge with a concrete, achievable response. Students leave with increased environmental knowledge, a functional prototype, and a personal commitment to action.

The module works as a standalone environmental science unit or as the culminating part of the full Integrated Exploration curriculum. Students who have completed Modules 1 and 2 will be able to bring coding, robotics, and art-science skills directly into their Eco-Tech projects.

What This Guide Contains

-  Five 60-minute lesson plans covering global challenges, renewable energy, circular economy, eco-tech design, and community action
-  A 5-day intensive workshop programme culminating in a Community Showcase
-  Pre/post quiz, Eco-Tech project rubric, Impact Report template, self-reflection, and action commitment cards
-  Integrates all three modules: coding (M1), art-science (M2), and sustainability (M3)
-  Designed to connect global environmental challenges to local, actionable responses

Module Overview

Module 3 brings together everything students have learned and directs it toward the most urgent challenges of their generation: climate change, resource depletion, biodiversity loss, and pollution. Students understand the science, recognise the systems at play, and design practical, technology-enhanced solutions. They then present these solutions to a real community audience.

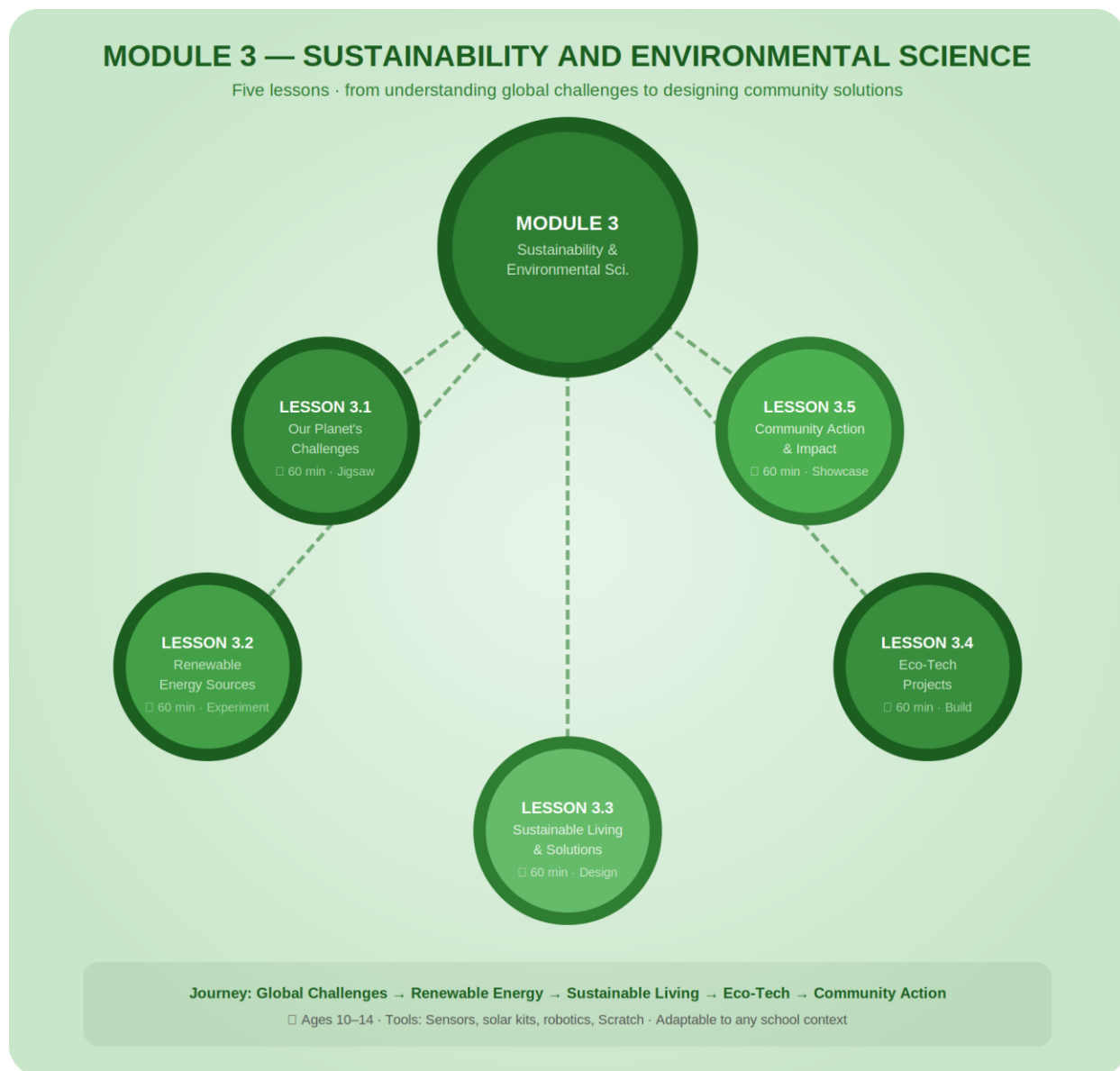


Figure 1 — Module 3: five lessons building toward a Community Showcase

At a Glance

- 🎯 **Target Group:** Students aged 10–14 and their teachers
- 🕒 **Lesson Time:** 5 × 60-minute lessons + 5-day intensive workshop

-  **Tools:** Environmental sensors, solar/wind kits, robotics (optional), Scratch, recycled materials
-  **Assessment:** Pre/post quiz, Eco-Tech rubric, Impact Report, self-reflection, action commitments
-  **Key Skills:** Environmental literacy, systems thinking, sustainable design, civic science communication

Six Global Environmental Challenges

Before students can develop solutions, they need clear scientific grounding in the problems. These six challenges were selected because they are well-documented, relevant globally and locally, actionable at multiple scales, and deeply interconnected.



Figure 2 — Six global environmental challenges: cause, measurable effect, and existing solutions

Systems Thinking — How Problems Connect

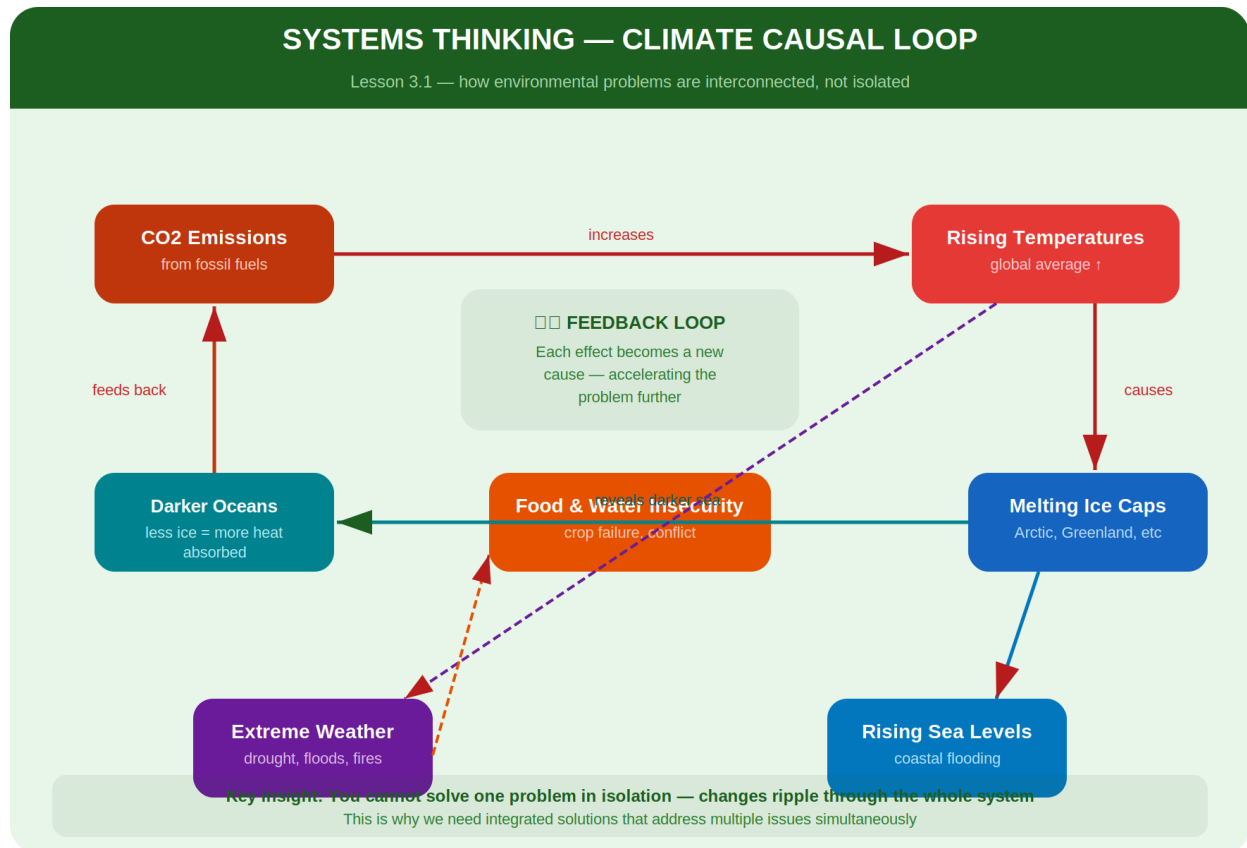


Figure 3 — Climate causal loop: how warming, ice melt, and extreme weather reinforce each other

The causal loop diagram shows that environmental problems cannot be solved in isolation — each effect becomes a new cause. This is why integrated solutions addressing multiple issues simultaneously are more powerful than single-issue interventions.

LESSON PLANS

Lesson 3.1 — Our Planet's Challenges

Duration	Materials	Grouping	Lesson Type
60 minutes	Six challenge fact sheets, causal loop handout, 2050 scenario cards, world map	Groups of 5–6, then reformed	Jigsaw + systems thinking

Learning Objectives

🎯 Learning Objectives:

1. Name and explain at least three global environmental challenges
2. Describe cause, effect, and one solution for their 'expert' challenge
3. Draw a simple causal loop connecting two environmental problems
4. Connect a global issue to a local example from their own community

Lesson Flow

Part 1 — 2050 Scenario Cards (15 minutes)

Pairs receive two scenario cards: life in 2050 under the current trajectory, and under a sustainable future. Mark: What is different? What decisions led to each future? Debrief: what would need to change, and at which level — individual, business, government, international? All three must act simultaneously.

Part 2 — Jigsaw Expert Groups (25 minutes)

Six groups study one challenge each (10 minutes). Prepare to explain: What is the problem? What causes it? Most alarming statistic? One existing solution? Reform into groups of six — one expert per challenge. Each expert teaches the others.

Part 3 — Local Connections (15 minutes)

Each student identifies one environmental issue visible in their neighbourhood or country. Draw a 3-step causal loop. Share in pairs: how does the same global trend show up differently in different places?

Part 4 — Systems Thinking Introduction (5 minutes)

Draw the simplified climate causal loop on the board. Introduce: feedback loop, interconnection, tipping point, leverage point. Preview: Lesson 3.2 explores how renewable energy can break this loop.

Environmental Issue	Key Statistic	One Existing Solution
Climate Change	Global average temperature +1.2°C since pre-industrial times	Renewable energy transition; energy efficiency standards
Biodiversity Loss	1 million species currently threatened with extinction	Protected areas; rewilding; sustainable agriculture
Water Scarcity	2 billion people lack access to safe drinking water	Water conservation; smart irrigation; desalination
Air Pollution	7 million deaths per year attributed to air pollution	Clean transport; industrial filters; urban green space
Plastic Waste	8 million tonnes of plastic enter oceans every year	Reduce single-use; chemical recycling; biodegradable materials
Deforestation	10 million hectares of forest lost per year globally	Sustainable forestry; reforestation; plant-based diets

Lesson 3.2 — Renewable Energy Sources

Duration	Materials	Grouping	Lesson Type
60 minutes	Mini solar panels, LEDs, wires, angle protractors, energy data cards	Groups of 3	Experiment + data analysis

Learning Objectives

- 🎯 Learning Objectives:
1. Describe how at least three renewable energy sources generate electricity
 2. Build a functional solar circuit and measure output at different angles
 3. Explain why solar potential varies by region and season
 4. Calculate how many panels would be needed to power their classroom

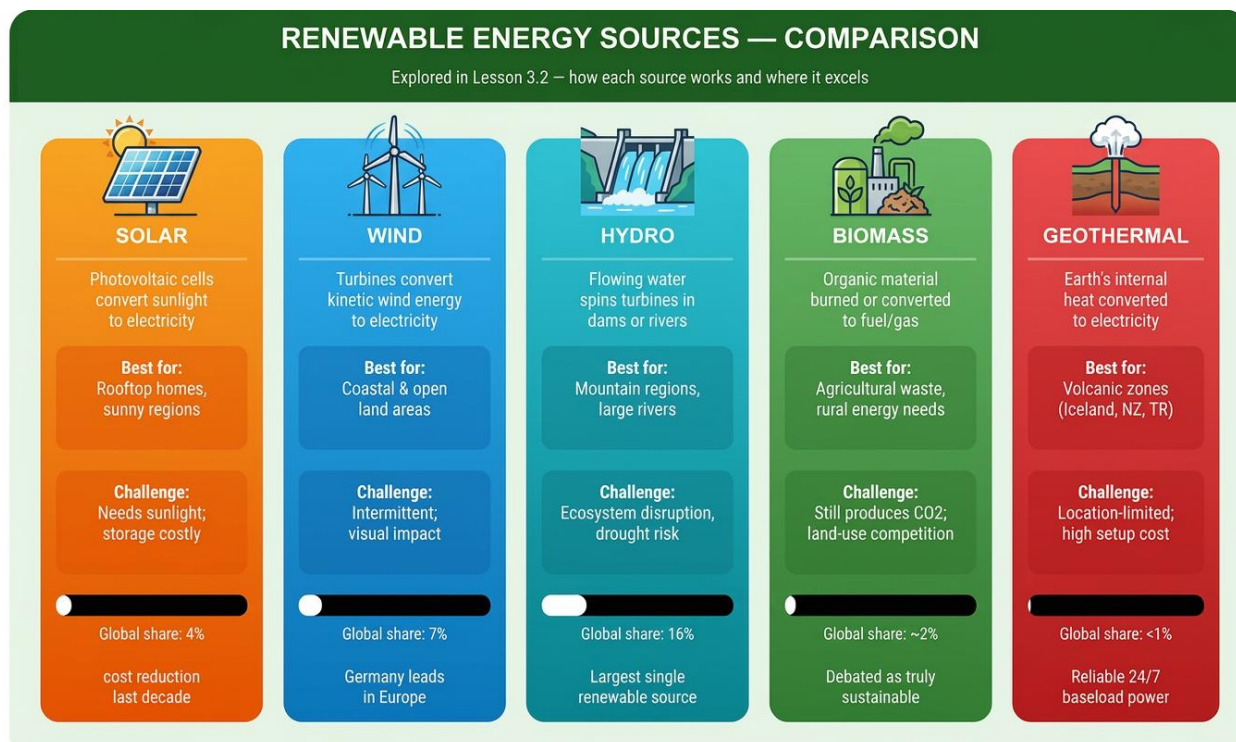


Figure 4 — Five renewable energy sources: how each works, its strengths, and its challenges

Lesson Flow

Part 1 — Energy Source Sort (15 minutes)

Card sort: students categorise 12 energy sources as Renewable/Non-renewable, then Produces CO₂/Does not produce CO₂. Discuss anomalies: nuclear (not renewable but low-carbon), biomass (renewable but produces CO₂). Key vocabulary: photovoltaic, kilowatt-hour, turbine, carbon neutral, intermittency.

Part 2 — Solar Circuit Build (25 minutes)

Groups build a solar panel → LED circuit. Conduct and record three experiments:

1. **ANGLE EXPERIMENT:** Test panel at 0°, 30°, 60°, 90° to light source. Which angle gives brightest LED?
2. **DISTANCE EXPERIMENT:** Move light source 20cm, 40cm, 60cm, 80cm away. Record output change.
3. **COVERAGE EXPERIMENT:** Cover ¼, ½, ¾ of panel. At what coverage does output drop to zero?

Part 3 — Real-World Calculation (15 minutes)

Challenge: how many solar panels would be needed to power your classroom for one school day? Provide: classroom daily electricity use (~8 kWh), typical solar panel output (0.15–0.2 kWh/m²/day in good conditions), and regional sun-hour data for students to look up. Compare results across climates. What does this tell us about where solar energy makes most economic sense?

Part 4 — Energy Transition Discussion (5 minutes)

Germany generates over 50% of electricity from renewables during peak hours — achieved through policy (feed-in tariffs), long-term investment, and citizen energy cooperatives. What combination of factors would be needed in your country to make a similar transition?

Lesson 3.3 — Sustainable Living and Solutions

Duration	Materials	Grouping	Lesson Type
60 minutes	Printed footprint calculator, circular economy case study cards, design challenge materials	Individual, then groups of 3	Reflection + design sprint

Learning Objectives

🎯 Learning Objectives:

1. Calculate and interpret a personal ecological footprint
2. Distinguish between linear and circular economy models
3. Design a product or service applying at least one circular economy principle
4. Write one SMART personal sustainability commitment

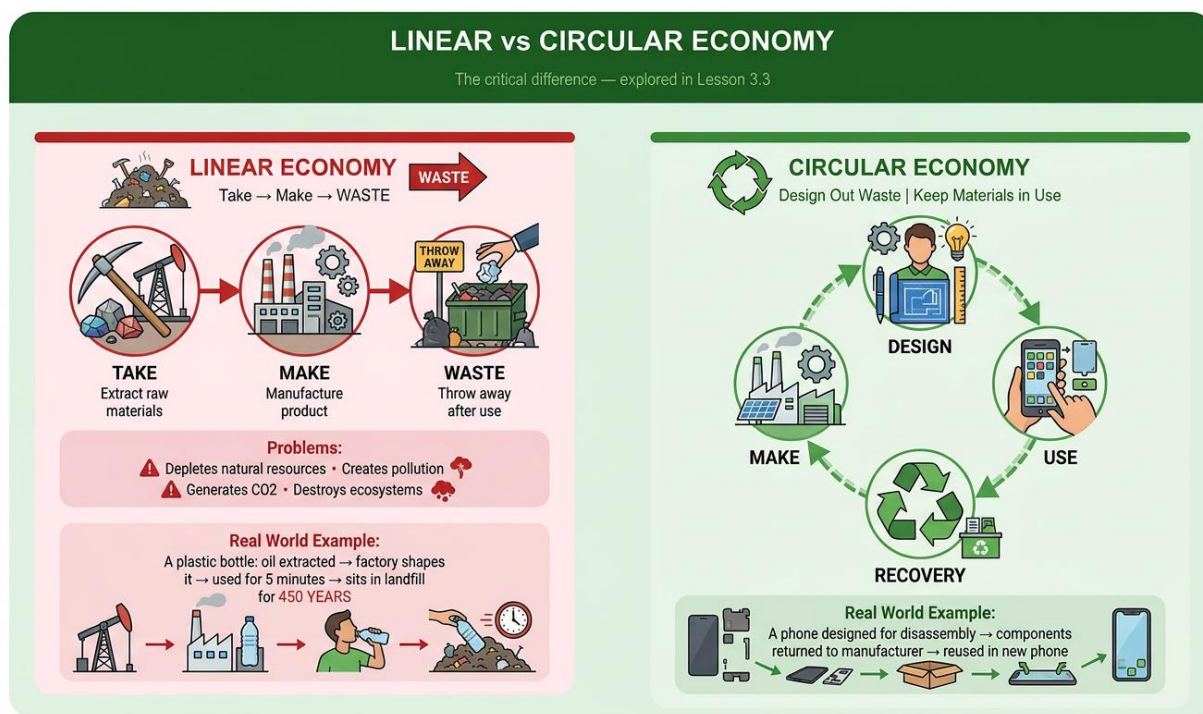


Figure 5 — Linear economy (Take → Make → Waste) vs Circular economy (design out waste, keep materials in use)

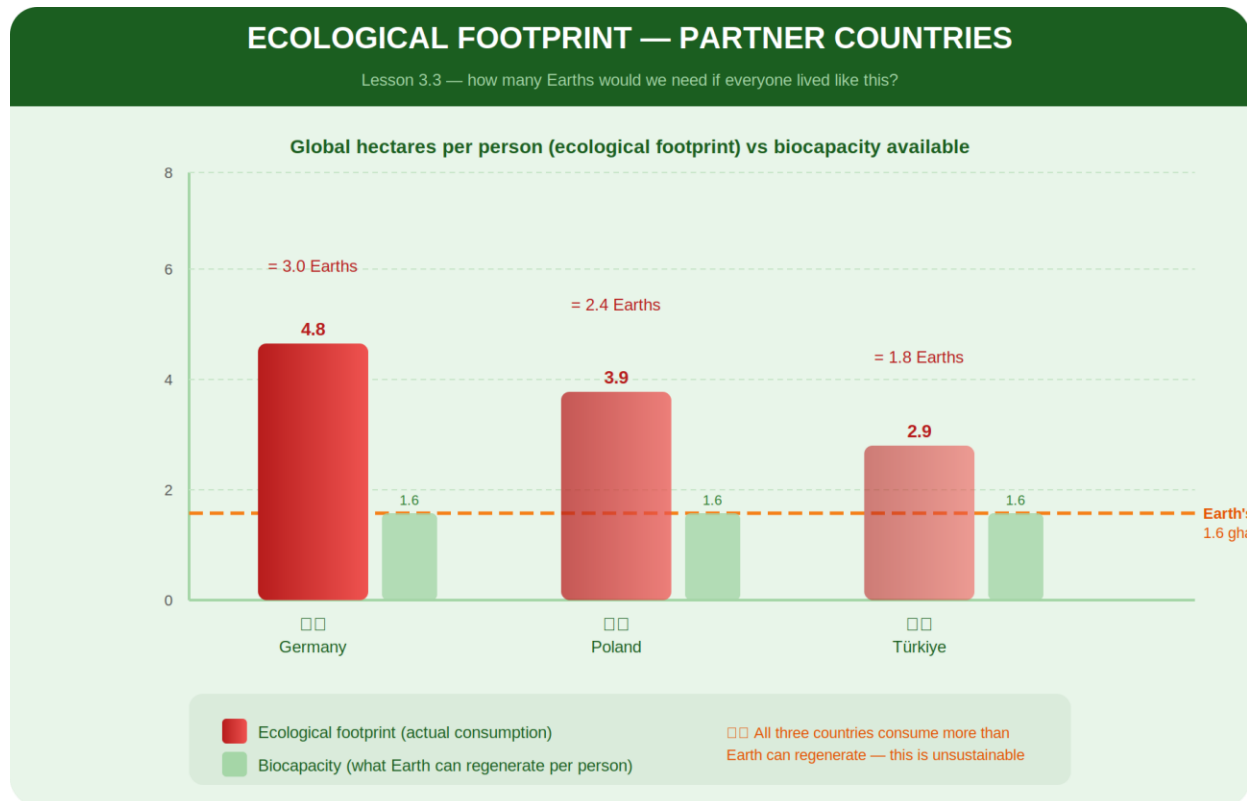


Figure 6 — Ecological footprint comparison across different regions — vs Earth's available biocapacity per person

Lesson Flow

Part 1 — Personal Footprint Calculator (20 minutes)

Students complete the footprint questionnaire covering food, transport, home energy, and consumption. Calculate a class average. Key question: if everyone on Earth lived like our class average, how many Earths would we need? Discuss: which category has the biggest impact? Which is most within our individual control?

Part 2 — Circular Economy Case Studies (15 minutes)

Three short case studies, one per group member — read and share:

4. Fairphone: smartphone designed for disassembly. Users replace any component. Currently lasts 5+ years vs industry average 2.5 years.
5. Mud Jeans: denim subscription model. Wear them, return them, they become new jeans. Reduces cotton water use by 70% per pair.
6. Loop Industries: chemical recycling of plastics that cannot be mechanically recycled — breaks down to molecular level and rebuilds indefinitely.

Groups answer: What circular principle does each use? (Repair / Reuse / Recycle / Redesign) What barrier prevents this from being the default everywhere?

Part 3 — Sustainable Design Sprint (20 minutes)

Challenge card: design a product or service to replace a wasteful item students use regularly. Required outputs: sketch of the product/service, circular principle applied, target user, one obstacle and a possible response. Present in 60 seconds each.

Part 4 — SMART Commitment Cards (5 minutes)

Each student writes one SMART action: Specific, Measurable, Achievable, Relevant, Time-bound. Example: 'I will eat one meat-free day per week for four weeks and note it in my phone.' Cards are collected and returned at the workshop Day 5 — students review whether they kept their commitment.

Lesson 3.4 — Eco-Tech Projects

Duration	Materials	Grouping	Lesson Type
60 min + project time	Environmental sensors, micro:bit/Arduino, robotics kits (optional), solar panels, recycled materials	Groups of 3–4	Design + prototype build

Learning Objectives

🎯 Learning Objectives:

1. Complete an Eco-Tech Project Canvas integrating all three module themes
2. Connect an environmental sensor and record real data from three locations
3. Begin building a functional prototype
4. Draft a preliminary Impact Report answering: who benefits and how much?

ECO-TECH PROJECT CANVAS

Used in Lesson 3.4 — plan your technology + sustainability + art project

PROJECT TITLE: _____

TEAM MEMBERS (countries): _____

□ ENVIRONMENTAL PROBLEM
Which specific problem does your project address?

□ TECHNOLOGY USED
Sensors / coding / robotics / renewable energy?

□ ARTISTIC ELEMENT
How does art communicate your environmental message?

□□ SUSTAINABILITY PRINCIPLE
Circular economy / renewable energy / waste reduction?

□ POTENTIAL IMPACT
Who benefits? How many people / how much CO2 saved?

□□ MAIN OBSTACLE
What would need to change for this to scale up?

Figure 7 — Eco-Tech Project Canvas: the planning tool for Module 3 projects

Lesson Flow

Part 1 — Eco-Tech Case Studies (10 minutes)

Project	Technology	Environmental Problem	Lesson
Air Quality Egg	Sensors + IoT network	Urban air pollution monitoring	Low-cost sensors can give communities data previously only available to governments
Seabin	Floating pump + mesh bag	Marine plastic in marinas	Simple engineering + consistent use = 1.5kg debris per day per device
Plantix	AI + smartphone camera	Pesticide overuse in agriculture	10 million farmers now identify plant disease without chemicals

Discussion: what made each possible? Low-cost sensors, open data, creativity, and determination — not large companies or big budgets.

Part 2 — Project Canvas Design (20 minutes)

Groups complete the Eco-Tech Canvas. Integration requirement: projects must connect all three modules.

Module Connection	How It Appears in the Project
Module 1: Coding/Robotics	Some form of sensor, coding, or physical computing
Module 2: Arts & Science	An artistic element that communicates the environmental message
Module 3: Sustainability	A genuine environmental problem with a quantifiable impact

Key facilitation question: 'How does the technology make this solution better than without it? What can it do that a human cannot do alone?'

Part 3 — Sensor Data Collection (25 minutes)

Groups connect their sensor and collect data from three locations (e.g., different rooms, inside vs outside, near a road vs away from it). Record in a data table. Analysis questions: Where is the air quality worst? Is it better or worse than the outdoor reading? Why might this be?

💡 If sensors are unavailable: provide pre-collected data sets from real schools in different climates. Students analyse the data and build a Scratch visualisation — bridging back to Module 2 data art.

Part 4 — Impact Report Draft (5 minutes)

Two written questions to start the Impact Report: (1) If our project worked perfectly, who or what would benefit, and how? (2) What would need to be true for this to exist in 100 schools instead of one?

Lesson 3.5 — Community Action and Impact

Duration	Materials	Grouping	Lesson Type
60 minutes	Completed projects, Impact Report template, action worksheets, invited guests if possible	Groups + whole class	Public showcase + civic engagement

Learning Objectives

🎯 Learning Objectives:

1. Present an Eco-Tech project to a non-specialist audience
2. Complete a structured Impact Report with realistic estimates
3. Write and submit one specific action proposal to school leadership
4. Articulate the single most important insight from the full module

Lesson Flow

Part 1 — Community Showcase (25 minutes)

Each group presents for 3 minutes to an invited audience (ideally school leadership, parents, or community members):

7. The problem: 'The environmental issue we are addressing is...' (10 seconds)
8. The solution: 'Our project uses [technology] to...' (40 seconds)
9. The art element: 'We communicate our message through... because...' (20 seconds)
10. The impact: 'If scaled to [X] schools/locations, this could...' (40 seconds)
11. The ask: 'To make this real, we would need...' (10 seconds)

Part 2 — Impact Report (20 minutes)

Section	What to Include
Problem statement	Scientific evidence cited with source
Solution description	Technical explanation of how the project works
Beneficiaries	Who and how many could benefit if scaled
Environmental impact	Quantified reduction in harm or measurable improvement
Implementation needs	Resources, policy, and support required
Obstacles and responses	Realistic barriers and specific responses to each

Part 3 — School Action Proposals (10 minutes)

Each student writes one proposal to submit to school leadership. Must be: specific (not 'improve sustainability'), achievable within one year, and evidence-based (linked to project findings).

Part 4 — Module Synthesis (5 minutes)

Each student completes: 'The most important thing I now understand that I did not before this project is...'
Read aloud (anonymously if preferred). These responses become the most powerful evidence of learning transformation in any impact report.

5-DAY INTENSIVE WORKSHOP PROGRAMME

Five-Day Workshop — Sustainability and Environmental Science

This workshop is the intensive version of Module 3. Students who have completed Modules 1 and 2 arrive with coding, robotics, and art-science skills ready to deploy. The Community Showcase on Day 5 is a real event — not a school exercise. Real community members are invited; the audience matters.

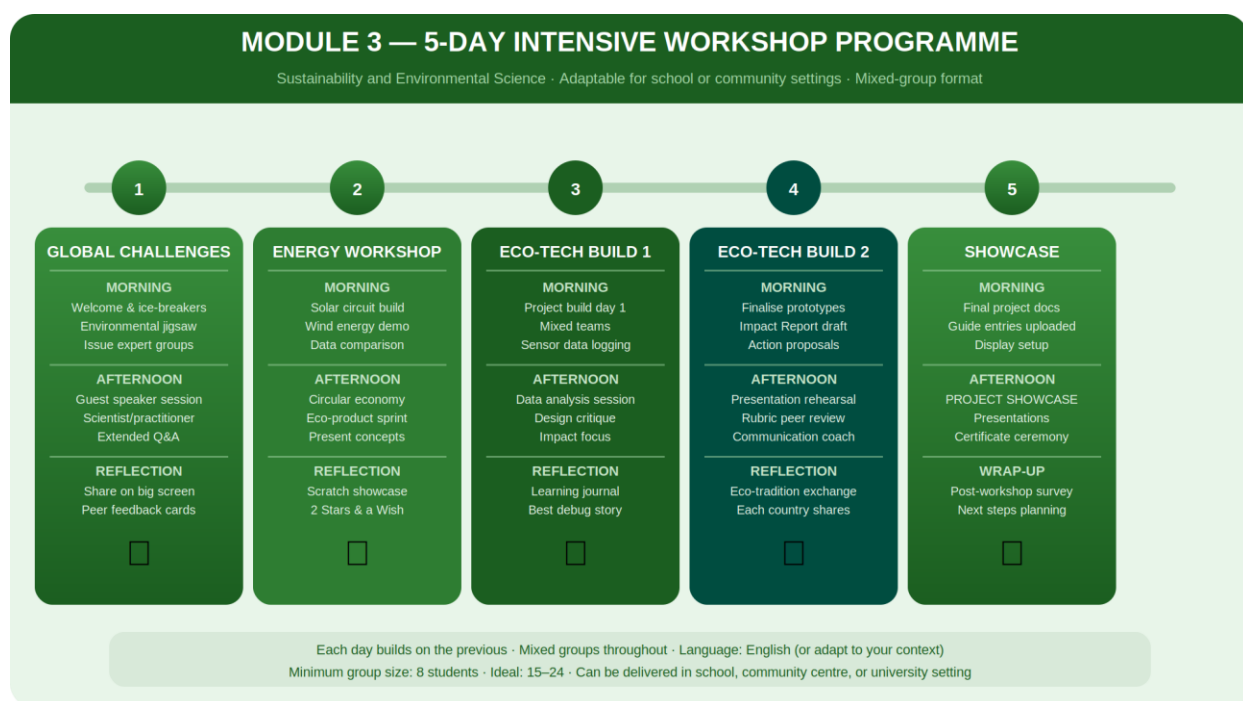


Figure 8 — Five-day workshop: five focused days building to a Community Showcase

Day	Theme	Morning Focus	Afternoon Focus	Reflection Activity
1	Challenges	Environmental jigsaw; local connections; guest speaker or video	Q&A; what surprised you most? Systems thinking intro	Evening: sustainability quiz; compare notes across participants
2	Energy & Design	Solar circuit build; renewable energy comparison; regional data	Circular economy workshop; eco-product design sprint	City/neighbourhood walk: find one example of sustainability in action
3	Build Day 1	Eco-Tech project build; sensor setup;	Data analysis; design critique: is	Progress sharing: biggest challenge + what help is needed

Day	Theme	Morning Focus	Afternoon Focus	Reflection Activity
		data logging from 3 locations	technology solving or decorating?	
4	Build Day 2	Finalise prototypes; complete Impact Report; write action proposals	Presentation rehearsal; rubric peer review; communication coaching	Cultural exchange: each group shares a sustainability tradition or law from their context
5	Showcase	Final prep; SMART commitment cards distributed; documentation uploaded	COMMUNITY SHOWCASE open to wider audience; award ceremony	Commitment card read-out; post-workshop survey; synthesis sentence

-  **Hope, not despair:** Environmental education can overwhelm students. Every session should end with at least one concrete, achievable solution. The Day 5 commitment cards make action feel personal and possible.
-  **Real data only:** Eco-Tech projects must use actual sensor readings, not invented numbers. This is what separates a genuine contribution from a school exercise.
-  **Community Showcase is not optional:** A real audience changes the quality of student work. Invite parents, local council members, sustainability professionals, or university partners.
-  **Document everything:** Photographs, video of presentations, and uploaded project entries create a lasting legacy for students and provide evidence for any reporting requirements.

ASSESSMENT TOOLS

Pre/Post Knowledge Quiz — Sustainability & Environmental Science

#	Question	Correct Answer
1	What does 'renewable energy' mean?	B — Energy from sources that naturally replenish
2	Which of these is NOT a greenhouse gas?	C — Oxygen
3	What is biodiversity?	A — The variety of life on Earth
4	The circular economy aims to:	B — Design out waste and keep materials in use
5	Which energy source produces NO CO ₂ during generation?	C — Wind power
6	What is an ecological footprint?	B — The impact of a person's lifestyle on the environment
7	Global temperatures have risen approximately how much since pre-industrial times?	C — 1.2°C
8	Sustainable development means:	B — Meeting present needs without compromising future generations' ability to meet theirs
9	Deforestation contributes to climate change mainly by:	A — Releasing stored CO ₂ into the atmosphere
10	Which is a personal sustainability action?	B — Choosing products with less packaging

Eco-Tech Project Rubric

Criterion	Beginning (1)	Developing (2)	Proficient (3)	Exemplary (4)
Environmental Understanding	No clear problem; significant scientific errors	Problem identified but poorly understood	Accurate problem with scientific evidence cited	Deep understanding of cause, effect, and systemic connections
Technical Solution	No prototype or plan; no technology used	Concept without working prototype	Functional prototype using sensor/coding to address the problem	Innovative solution; technology is essential, not decorative

Criterion	Beginning (1)	Developing (2)	Proficient (3)	Exemplary (4)
Sustainability Principles	No genuine principle applied	Sustainability mentioned without specificity	Clear application of at least one principle	Multiple principles integrated coherently with evidence
Artistic/Communication Element	Absent or tokenistic	Present but disconnected from the message	Artwork enhances communication and engages audience	Artwork is inseparable from the message; science cannot be as well communicated without it
Impact Awareness	Cannot describe impact	Vague or unrealistic claims	Realistic impact with rough quantification	Detailed Impact Report: beneficiaries, quantities, implementation path, honest obstacles
Presentation	Unclear or absent	Basic description; limited engagement	Clear, structured presentation covering all required elements	Compelling; uses real data; confident handling of questions

Student Self-Reflection — Module 3

Question	Response Format
Which environmental issue concerns me most and why?	Open text (2–3 sentences)
What is the most important thing I learned about sustainability?	Open text (2–3 sentences)
Has my behaviour or thinking changed? If so, how?	Open text (2–3 sentences)
What action am I committing to in my school or community?	One specific, measurable action
How confident am I in explaining sustainability to a non-expert? (1–5)	Circle: 1 2 3 4 5
How much do I believe young people can make a real difference? (1–5)	Circle: 1 2 3 4 5
One sentence I would say to a younger student about why this matters:	Open text