

GREENFUTURES

Lesson 3: Sustainable Systems: Energy, Nature, Food and Cities

Teacher Guide

This is the third of four GreenFutures lessons. Having covered climate science and AI, this lesson turns to the physical systems - energy, nature, food, cities - that climate action must ultimately change, always grounded in a real Irish example.

Time	~55 minutes (flex to a 40-minute class by trimming discussion time and one activity, as noted in the walkthrough below)
Background	Builds on Lessons 1 and 2. No new technical prerequisites, though the AI vocabulary from Lesson 2 (bias, pattern recognition) is referenced briefly when discussing AI-supported systems.
Materials Needed	PowerPoint presentation, laptop, screen, timer, students' climate journals.

Curriculum Links

GreenFutures is designed as an NCCA-compliant, cross-curricular Transition Year module (Science, Geography, CSPE, Digital Media). Its interactive and reflective activities build the five key skills central to Transition Year:

- Information processing
- Critical and creative thinking
- Communicating
- Working with others
- Being personally effective

Leaving Certificate subject links: Geography, Politics and Society, Technology, Computer Science, Business, Economics.

Learning Intentions

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

- Describe how energy, nature, food and cities each contribute to climate change
- Compare renewable and non-renewable energy systems
- Explain why biodiversity and healthy ecosystems matter, as a crisis connected to but distinct from climate change
- Identify sustainable approaches to food, transport and everyday consumption
- See how AI supports smarter, more sustainable infrastructure

Module Overview

Introduction (~3 mins)

Recap and preview today's four systems.

Energy and Nature (~14 mins)

Cover renewable energy and biodiversity, each with a grounding Irish example.

Food and Cities (~14 mins)

Cover agriculture and urban sustainability, each with a grounding Irish example - handle the farming example with care.

Weigh the Trade-Off and Apply (~18 mins)

Students debate a real trade-off, then propose one improvement to a system close to home.

Recap and Close (~3 mins)

Consolidate and preview Lesson 4.



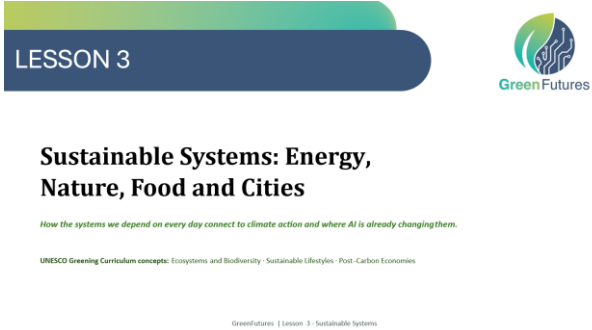
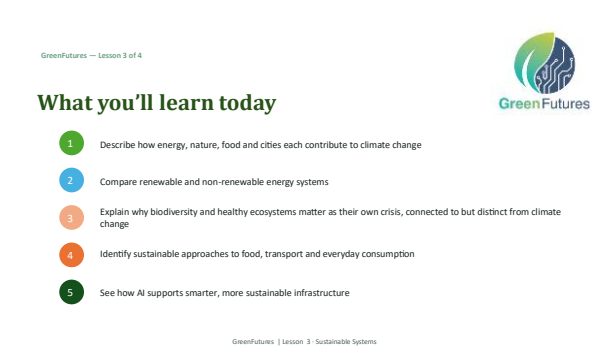
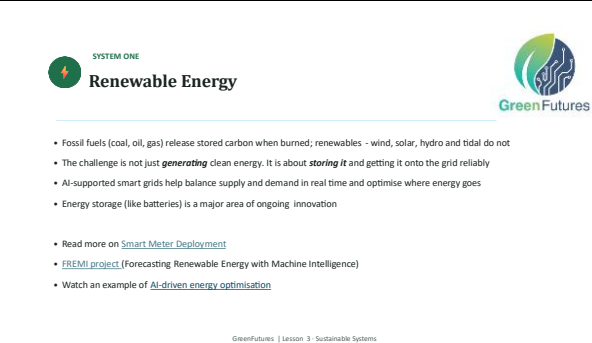
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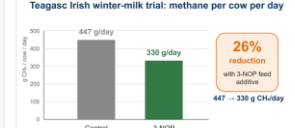
This project is funded within the framework of the UNESCO and Huawei collaboration, 'Digital Futures for a Smart Europe: A Feasibility Study on Digital Transformation and Green Innovation'

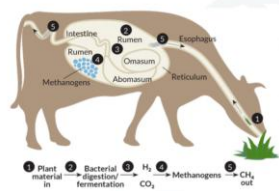
Lesson 3 Module Walkthrough

Each row below shows the slide alongside facilitation notes. Timings are approximate and add up to the total above; trim discussion prompts first if running short on time.

Introduction (~3 mins)	
 LESSON 3 Sustainable Systems: Energy, Nature, Food and Cities <i>How the systems we depend on every day connect to climate action and where AI is already changing them.</i> UNESCO Greening Curriculum concepts: Ecosystems and Biodiversity - Sustainable Lifestyles - Post-Carbon Economies GreenFutures Lesson 3 - Sustainable Systems	LECTURE (~1 min) Briefly recap Lessons 1 and 2. Tell students today connects everything so far to four everyday systems: energy, nature, food and cities.
 GreenFutures — Lesson 3 of 4 What you'll learn today 1 Describe how energy, nature, food and cities each contribute to climate change 2 Compare renewable and non-renewable energy systems 3 Explain why biodiversity and healthy ecosystems matter as their own crisis, connected to but distinct from climate change 4 Identify sustainable approaches to food, transport and everyday consumption 5 See how AI supports smarter, more sustainable infrastructure GreenFutures Lesson 3 - Sustainable Systems	LECTURE (~2 mins) Walk through today's five learning outcomes.
 SYSTEM ONE Renewable Energy • Fossil fuels (coal, oil, gas) release stored carbon when burned; renewables - wind, solar, hydro and tidal do not • The challenge is not just generating clean energy. It is about storing it and getting it onto the grid reliably • AI-supported smart grids help balance supply and demand in real time and optimise where energy goes • Energy storage (like batteries) is a major area of ongoing innovation • Read more on Smart Meter Deployment • FREMI project (Forecasting Renewable Energy with Machine Intelligence) • Watch an example of AI-driven energy optimisation GreenFutures Lesson 3 - Sustainable Systems	LECTURE (~4 mins) Cover fossil fuels vs. renewables, and the storage/grid challenge. Introduce AI-supported smart grids as a real application. ESB: Smart Meter Deployment FREMI project (Forecasting Renewable Energy with Machine Intelligence) ESB and GridVision AI-driven energy optimisation by GridBeyond: https://www.youtube.com/watch?v=qMXm-xkToAM https://gridbeyond.com/about-us-2/

11 Irish Example Ireland's Energy Transition - Wind energy is central to Ireland's electricity mix and its expansion is the subject of a genuine, ongoing national debate about where turbines should go and how quickly to build - Bord na Móna, once one of Ireland's largest peat-cutting companies, has shifted most of its business from peat extraction to renewable wind energy - This is a useful real-world example of what a 'just transition' looks like in practice, an economy changing direction, and the people within it adapting GreenFutures Lesson 3 Sustainable Systems	LECTURE (~3 mins) Present the Irish wind-energy example and Bord na Móna's shift from peat to wind, framed as a real 'just transition' story.
SYSTEM TWO Biodiversity and Nature - Biodiversity loss is a distinct but overlapping crisis to climate change. Driven also by land-use change, invasive species and pollution, not climate alone - Nature-based solutions such as protecting and restoring forests, wetlands and peatlands can absorb carbon while also protecting wildlife - AI supports this work too: satellite imaging and monitoring tools now track deforestation, habitat change and wildlife populations at a scale no human team could manage alone - Watch video here on Using Technology to Protect Global Bee Population (Cork) - Measuring and monitoring biodiversity on and around onshore wind farms: What Nature+Energy project is and how does it work? GreenFutures Lesson 3 Sustainable Systems	LECTURE (~4 mins) Introduce biodiversity loss as a distinct but overlapping crisis to climate change, driven also by land-use change, invasive species and pollution. Cover nature-based solutions and AI-supported monitoring. AvisProtect (Cork) video on bee population Measuring and monitoring biodiversity on and around onshore wind farms: What Nature+Energy project is and how does it work? https://www.irishtimes.com/news/environment/nature-energy-project-to-benefit-vicinities-of-wind-farms-1.4612421
11 Irish Example Ireland's Peatlands: A Distinctive Landscape - Ireland's peatlands and bogs are internationally significant carbon stores, and distinctive to our landscape - Bord na Móna's peatland restoration programme is actively rewetting and restoring cutaway bogs, turning former industrial sites back into functioning carbon sinks and habitats - This connects the energy story and the biodiversity story: the same organisation, changing direction on two fronts at once - Watch video here on AI2Peat (UCD Research) GreenFutures Lesson 3 Sustainable Systems	LECTURE (~3 mins) Present Ireland's peatlands as a distinctive landscape and Bord na Móna's peatland restoration programme, this deliberately echoes back to the wind-energy slide, showing one organisation changing direction on two fronts. AI2Peat (UCD Research) video More on the project: https://www.ucd.ie/research/impact/casestudies/ai2peattheall-irelandaiplatformpoweringsmarterpeatlandmanagement/ https://www.rte.ie/news/ireland/2025/1117/1544305-irish-ai-climate/

SYSTEM THREE Agriculture and Food Systems - Food systems are a major source of greenhouse gas emissions worldwide, particularly from livestock and land use - AI is already used in precision agriculture, predicting crop yields, targeting fertiliser use, and reducing food waste - Watch video on Monitoring of Crop Pests HAY ID (Teagasc) - An example of how a school project came about by students in TU Dublin. Project Micron Agritech uses AI for rapid worm testing to fight antimicrobial resistance in animals - See the project at the Ploughing Championship too - Sustainable farming approaches aim to reduce environmental impact while keeping food systems productive and viable GreenFutures Lesson 3 - Sustainable Systems	LECTURE (~4 mins) Cover food systems' emissions, AI in precision agriculture, and reducing fertiliser use and food waste. Monitoring of crop pests (Teagasc) Ploughing: How Micron Agritech uses rapid worm testing to fight antimicrobial resistance. The project was developed as part of a school project by TU Dublin students, great example and inspiration for the TY students: https://www.youtube.com/watch?v=vvrklQxxyaw
(6) Irish Example - Handle with Care Farming Fairly: Ireland's Beef and Dairy Sector - Beef and dairy farming is central to rural Ireland's identity and economy and also a major source of national methane emissions - Teagasc (Ireland's agriculture and food development authority) has set sustainability targets that create real tension for many farming communities - This is genuinely complex, not a simple 'right or wrong'; farmers face pressure from both climate policy and economic survival - Frame this as a question, not a verdict: 'how do we transition fairly?' - see the Teagasc AI in agriculture case study for a more hopeful angle on the same sector GreenFutures Lesson 3 - Sustainable Systems	LECTURE/DISCUSSION - HANDLE WITH CARE (~4 mins) Present the beef and dairy example. This is the most sensitive slide in the module - read the framing note aloud if useful: the aim is to present real complexity and pressure on farming communities, not to hand down a verdict. https://teagasc.ie/news--events/daily/how-artificial-intelligence-is-shaping-the-future-of-irelands-food-industry/
AI in Dairy: Reducing Methane Measure + Predict + Reduce AI helps measure and predict where reductions are possible; breeding, feed and management deliver the reduction. How AI fits into the dairy methane problem 1 Measure GreenFeed measures methane (CH₄) and other gases from cattle breath. 2 Predict Machine learning models use the data to predict methane output. 3 Reduce Use predictions to support lower-methane breeding, feeding and management interventions. Key teaching point: The AI output is a prediction. The physical reduction comes from an action such as genetics, diet or a methane inhibitor. Irish AI example VistaMilk lists research on predicting methane emissions of individual grazing dairy cows from spectral analysis of milk samples. 62.5% of Irish agricultural emissions are enteric methane 1,500+ animals 18 breeds • 11% of methane differences linked to genetics Teagasc Irish winter-milk trial: methane per cow per day  Control: 447 g/day 3-NOP: 330 g/day 26% reduction with 3-NOP feed additive 447 → 330 g CH₄/day AI helps identify which cows, diets or interventions are most promising; the intervention itself causes the methane reduction. Sources: Teagasc GreenFeed and 3-NOP research; ICSP methane evaluations; VistaMilk publications. Figures amplified for teaching.	3-NOP Winter Milk Trial https://teagasc.ie/animals/dairy/dairy-levy-research/winterliquid-milk-production/ GreenFeed Research Update: https://teagasc.ie/environment/climate-change-air-quality/signpost-programme/research-updates/ ICBF Methane https://www.icbf.com/methane/

AI in Dairy: Reducing Methane Measure • Predict • Reduce Methane production cycle  • Enteric methane responsible for 60.7% of agri-emissions (EPA, 2022) • Reductions in methane increase environmental sustainability • 2-12% gross energy intake loss from methanogenesis • Additional increase in economic sustainability icbf  AgTech – it's in our DNA	
SYSTEM FOUR Sustainable Cities and Consumption  • Transport and urban infrastructure are major sources of emissions and major opportunities for change • The circular economy: reduce, reuse, redesign, rethink how we make and use things instead of throwing them away • Our everyday buying choices (clothes, phones, packaging - think fast fashion!) connect directly to circular economy thinking • AI supports smart cities: optimising traffic flow, public transport routing and energy use across a whole city • Examples range from CitySwift, partnering with Bus Éireann, LIFE EMERALD measuring air-pollution to Artificial Intelligence as an Enabler of the Circular Economy GreenFutures Lesson 2 - AI, Ethics and Climate Solutions	LECTURE (~4 mins) Cover urban emissions, the circular economy (reduce/reuse/redesign), everyday consumption choices (fast fashion, overconsumption!) and AI-supported smart cities. Examples range from CitySwift, partnering with Bus Éireann LIFE EMERALD measuring air-pollution https://airquality.ie/ Circular Economy (EPA): Artificial Intelligence as an Enabler of the Circular Economy https://www.epa.ie/publications/research/reports/Research_Report-492.pdf Potential question for discussion: why do you think adoption lags here, when Ireland is otherwise ahead on AI?
Irish Example Irish Cities in Transition • Dublin has seen a major shift toward cycling infrastructure, Luas expansion and improved bus connections in recent years • Dublin has also piloted AI-powered smart-city traffic systems, working with technology partners to optimise traffic flow in real time. • Together these show a city actively experimenting with both infrastructure and technology to become more sustainable • Watch a video on Dublin's Travel and Road Safety, AI Smart City GreenFutures Lesson 3: Sustainable Systems	LECTURE (~3 mins) Present Dublin's cycling infrastructure, Luas expansion and bus network as a transport example, and the Dublin smart-city traffic pilot as the AI-supported example. Other examples from around the country? Watch a video: https://vivacitylabs.com/smart-city-dublin-using-nvidia-bentley-systems/

ACTIVITY ~10 minutes  Weigh the Trade-Off 1. In small groups, take one system from today's lesson: energy, farming, or transport 2. List one clear benefit and one clear trade-off/cost of the sustainable option (involving AI) in that system (e.g. wind energy: clean power vs. visual/land-use impact) 3. Decide as a group: on balance, is it worth it? Be ready to defend your reasoning 4. Quick self-check: did your group consider more than one perspective (e.g. environmental, economic, and community)? GreenFutures Lesson 3 - Sustainable Systems	ACTIVITY (~10 mins) Small groups take one system (energy, farming or transport), list one benefit and one trade-off of the sustainable option involving AI and decide as a group whether it is worth it. Prompt groups to check they have considered more than one perspective (environmental, economic, community) before deciding.
APPLY IT ~8 minutes  Improve a System Close to You Pick one system - energy, food, transport or waste - in your own school or town. Identify one realistic improvement that could make it more sustainable, and one thing that would need to happen to make it work. How they show their work: Students sketch or write their proposal in their climate journal - a short paragraph or annotated diagram. GreenFutures Lesson 3 - Sustainable Systems	APPLY (INDIVIDUAL, CAPTURED) (~8 mins) Students pick one system in their own school or town and propose one realistic improvement, sketched or written in their climate journal. Keep this grounded and local (their own canteen, bus route, bin system) rather than abstract. It feeds into the bigger Lesson 4 action proposal.
 What have we learned? ✓ We've connected energy, nature, food and cities to climate action ✓ We've seen real Irish examples of sustainable transition and the trade-offs involved ✓ We understand where AI already supports smarter, more sustainable systems ✓ We've proposed one realistic improvement to a system close to home Next lesson: we turn to climate justice, the future, and how we can all be part of the response. GreenFutures Lesson 3 - Sustainable Systems	LECTURE (~2 mins) Revisit the five learning outcomes.
 See you in Lesson 4: Climate Justice, Futures Thinking and Green Innovation Developed by the ADAPT Research Centre in partnership with Huawei and UNESCO. GreenFutures Lesson 3 - Sustainable Systems	LECTURE (~1 min) Preview Lesson 4: Climate Justice, Futures Thinking and Green Innovation.