AI for Green Transition and Sustainability

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Learning goal

The green transition – the shift toward a low-carbon, resource-efficient and climate-resilient economy – is one of the defining challenges for the sectors that vocational education and training (VET) prepares learners to enter. Artificial intelligence (AI) helps to forecast, optimise, monitor and decide in ways that can reduce energy use, waste and emissions. At the same time, AI is itself a digital technology with a measurable environmental footprint.



For VET teachers, this double character is exactly what makes the topic valuable. It lets us connect AI literacy with environmental responsibility and teach learners that a technology is never "green" or "not green" in the abstract: it depends on how, where and why it is used. This learning material gives an overview of where AI genuinely supports sustainability, where its environmental costs lie, and how to bring both sides into vocational teaching as a single, critically aware competence.

Where AI supports the green transition

AI does not replace renewable technologies, efficient machines or good design – it makes them work better by finding patterns in large amounts of data and turning those patterns into decisions. Five application areas are especially relevant for VET.

Energy optimisation

Electricity systems based on solar and wind are variable: production rises and falls with the weather.



AI models forecast both electricity demand and renewable generation, helping operators balance the grid, decide when to store energy in batteries, and reduce reliance on fossil back-up plants. At a smaller scale, building energy management systems use AI to control heating, cooling and lighting according to occupancy and weather, while predictive-maintenance models

detect when a wind turbine, heat pump or solar inverter is starting to underperform before it fails.



Environmental monitoring

By combining satellite imagery, drones and ground sensors, AI can detect deforestation, monitor air and water quality, identify gas or methane leaks, track biodiversity, and flag illegal activity such as unregulated fishing or logging. This turns scattered raw data into early, actionable information that would be impossible to process manually at scale.

Sustainable design

In engineering and manufacturing, generative-design tools propose component shapes that use less material while keeping the required strength. AI also supports life-cycle assessment — estimating the environmental impact of a product from raw material to disposal — and helps explore alternative, less harmful materials. Designing efficiency in from the start is often more powerful than improving a process later.



Resource efficiency

In agriculture, AI-guided "precision" approaches apply water, fertiliser and pesticide only where and when they are needed. In industry and logistics, route optimisation cuts fuel use, and AI-driven waste sorting improves recycling and supports the circular economy. The shared idea is always the same: doing more with less.





Climate-related decision support

Improved weather and climate models, early-warning systems for floods, heatwaves and wildfires, and risk-assessment tools help communities, businesses and public bodies prepare for and adapt to a changing climate. Here AI supports human decisions rather than making them automatically.

The environmental cost of AI

It would be a mistake to see AI only as a green solution, and this one-sided view should not be taught: understanding the environmental cost of AI is also part of AI literacy.

Digital technologies, and large-scale AI in particular, carry real environmental costs that learners should understand:



Energy and emissions
Training and running large AI models requires powerful computing in data centres that consume significant electricity. If that electricity comes from fossil sources, it produces carbon emissions.

Water
Many data centres use large volumes of water for cooling, which matters especially in regions already under water stress.

Hardware and e-waste
AI depends on specialised chips and servers whose manufacture uses energy, water and mined materials, and which eventually become electronic waste.

The rebound effect
Efficiency gains do not automatically reduce total impact. When something becomes cheaper or easier thanks to AI, people often simply do more of it – a pattern long known in economics as the rebound (or Jevons) effect. A tool may save energy for a given task, but it can increase overall consumption.

Reliable figures in this area vary widely and change quickly, so the pedagogical point is not to memorise numbers but to ask the right questions: What is the purpose of this AI use? Does the benefit outweigh the cost? Is there a simpler, lower-impact way to reach the same goal?

Bringing it into vocational teaching



The project's sectors, such as engineering, construction, IT, design, renewable energy, marketing and others – are precisely the fields where green-transition decisions are made every day, which puts teachers in a strong position to make this concrete. A few principles help:

- **Use sector examples**
  Show learners AI applications from their own trade rather than abstract cases: solar forecasting for energy students, generative design for engineering students, precision irrigation for agricultural students.
- **Always show both faces**
  Whenever you present AI as a sustainability solution, ask learners to also consider its footprint. This builds balanced judgement instead of hype or fear.
- **Make it a decision, not an opinion**
- Encourage learners to weigh benefit against cost with evidence, and to recognise that the answer often depends on context.
- **Connect to professional responsibility**

  Future technicians and designers will choose tools and methods; environmental awareness is part of doing the job well, not an optional add-on.

Short takeaway for teachers



AI is a powerful enabler of the green transition through optimisation, monitoring, design, resource efficiency and decision support — and, at the same time, a digital technology with energy, water and material costs plus rebound risks. Responsible AI literacy means evaluating each use case on whether its sustainability benefit genuinely outweighs its environmental cost.

In VET, the most effective approach is concrete and sector-based: present real examples from the learners' own trade and always show both faces of the technology so that students develop balanced, evidence-based judgement rather than hype or fear.

References

- European Commission — The European Green Deal and the twin green-and-digital transition.
- International Energy Agency (IEA) — reports on AI, data centres and energy use.
- GreenComp — the European sustainability competence framework, Publications Office of the EU (2022).

Links

European Green Deal: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

GreenComp framework: https://publications.jrc.ec.europa.eu/repository/handle/JRC128040

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