

# EDP VET



**Best Practices for Sustainability  
in VET**

**Digital Tools for  
Sustainability**

**Circular Economy and  
Sustainable Digital  
Practices**

**Environmental Impact of  
Digital Technologies**

**Green and Digital Transition  
in Vocational Education**

Co-funded by  
the European Union

2024-2-ES 01-KA210-VET-000280277





# ECO-DIGITAL PATHWAYS FOR VET

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THE EDP-VET TRAINING PACKAGE

is a digital booklet designed to support teachers, trainers and students in vocational education and training in integrating sustainable digital practices into educational and professional contexts.

This resource addresses the **Twin Transition**, aligning with the objectives of the **European Green Deal**, and offers practical guidance, active methodologies and concrete examples to promote green and digital skills.

Organised into five thematic modules, the booklet explores topics such as sustainability, the circular economy, the environmental impact of digital technologies and the responsible use of digital tools, contributing to the training of more aware, critical citizens who are prepared for the challenges of today's labour market.



## NOTE TO VET TEACHERS

### AND OTHER STAKEHOLDERS

This booklet was developed to support vocational education teachers in the challenge of integrating sustainability and digital transition into educational practices, particularly in the context of vocational education and training. In a scenario marked by climate urgency and rapid technological evolution, education plays a strategic role in preparing citizens and professionals to respond to these transformations in a critical, ethical, and responsible manner.

Throughout this material, you will find a conceptual framework, practical examples and suggested activities that help to link European objectives — such as the European Green Deal and the Digital Education Action Plan — to the concrete reality of the classroom and training contexts. The approach adopted values active methodologies, learning based on real problems and the integrated development of green and digital skills.

This booklet does not aim to add more content to the curriculum, but rather to support its adaptation by offering tools to make sustainability and digitalisation cross-cutting dimensions of teaching. Your role as a teacher is central to transforming these principles into meaningful learning with a lasting impact.



# 1

GREEN AND DIGITAL TRANSITION IN VOCATIONAL EDUCATION



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# 2

BEST PRACTICES FOR SUSTAINABILITY IN VET



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DIGITAL TOOLS FOR SUSTAINABILITY



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## MODULE 1

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# GREEN AND DIGITAL TRANSITION IN VOCATIONAL EDUCATION

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EUROPE IS UNDERGOING A PERIOD OF PROFOUND TRANSFORMATION MARKED BY TWO STRUCTURAL CHANGES THAT WILL SHAPE THE FUTURE OF SOCIETIES, ECONOMIES AND EDUCATION SYSTEMS: THE URGENT NEED TO TACKLE THE CLIMATE CRISIS AND THE RAPID DEVELOPMENT OF DIGITAL TECHNOLOGIES. THESE TWO PROCESSES — THE GREEN TRANSITION AND THE DIGITAL TRANSITION — DO NOT EVOLVE SEPARATELY; ON THE CONTRARY, THEY INFLUENCE AND REINFORCE EACH OTHER, CONSTITUTING WHAT THE EUROPEAN UNION CALLS THE GREEN AND DIGITAL TRANSITION (TWIN TRANSITION).

EDUCATION PLAYS A DECISIVE ROLE IN ENSURING THAT THESE CHANGES BECOME A SUSTAINABLE, EQUITABLE AND INCLUSIVE REALITY. IN PARTICULAR, VOCATIONAL EDUCATION AND TRAINING (VET) IS CALLED UPON TO PREPARE TECHNICIANS AND PROFESSIONALS CAPABLE OF APPLYING GREEN AND DIGITAL SOLUTIONS IN VARIOUS PRODUCTIVE SECTORS, CONTRIBUTING DIRECTLY TO THE EUROPEAN OBJECTIVES OF CLIMATE NEUTRALITY AND SUSTAINABLE COMPETITIVENESS.

THIS MODULE PROVIDES TEACHERS AND TRAINERS WITH GUIDANCE, RESOURCES AND GOOD PRACTICES THAT HELP THEM INTEGRATE SUSTAINABILITY AND DIGITAL SKILLS INTO THEIR TEACHING PRACTICES, ALIGNING THE WORK OF VOCATIONAL SCHOOLS WITH THE EUROPEAN GREEN DEAL AND THE DIGITAL EDUCATION ACTION PLAN.

### WHAT IS THE GREEN AND DIGITAL TRANSITION?

The Green Transition refers to the transformation needed to reduce emissions, protect biodiversity, promote energy efficiency, and implement circular models that extend the life cycle of products and minimise waste. This transition involves new ways of producing, consuming, mobilising resources, and managing energy systems.

The Digital Transition, in turn, translates into the widespread adoption of technologies such as artificial intelligence, cloud computing, big data, robotics, and the Internet of Things, which are profoundly transforming the way we communicate, work, and learn.

When combined, these transitions create the scenario we call the Twin Transition, where technology becomes an accelerator of sustainability. Practical examples include:

- Smart grids that automatically balance renewable energy with consumption.
- Precision agriculture that reduces water and fertiliser use through sensors and data.
- Green Industry 4.0, supported by digital simulations and digital twins that prevent waste.
- Hybrid learning environments that reduce travel and increase accessibility.

However, the Twin Transition also presents significant challenges: increasing energy consumption by digital infrastructure, extraction of raw materials for devices, increased electronic waste, and inequality in access to technologies. It is therefore essential that teachers and trainers help students understand both the opportunities and risks, developing critical thinking and responsible digital practices.



## WHY IS IT ESSENTIAL FOR THE FUTURE OF VET?

Vocational schools play a key role: they train technicians who apply innovative solutions for sustainability and digitalisation in the field. It is essential to empower teachers, trainers and students to:

- Actively address the environmental impact of technologies.
- Integrate circular economy practices into equipment management and recycling.
- Use sustainable digital tools, from eco-friendly cloud platforms to apps that help reduce your digital footprint.
- Promote environmental awareness and responsible technology consumption in educational and professional contexts.



## THE EUROPEAN GREEN DEAL AND THE ROLE OF VOCATIONAL EDUCATION

The European Green Deal is the European strategy to transform the European Union into the first climate-neutral economy by 2050. To this end, it proposes ambitious targets, including:

- Reduce greenhouse gas emissions by at least 55% by 2030.
- Increase the production and use of renewable energy.
- Accelerate the transition to a circular economy.
- Protect ecosystems through the conservation and regeneration of biodiversity.
- Ensure a Just Transition by supporting regions and workers in retraining processes.

The Green Deal explicitly recognises that these goals will only be achieved if there are skilled workers capable

of implementing sustainable practices in sectors such as energy, industry, transport, construction, logistics and agriculture. This is where VET gains strategic relevance.

Vocational schools have the potential to turn European guidelines into practical reality by training technicians capable of:

- Install and maintain renewable energy systems;
- apply circular maintenance and repair techniques;
- use energy-efficient digital tools;
- interpret environmental data to improve processes;
- implement eco-digital solutions in their professional contexts.

Thus, VET not only trains professionals, but also contributes directly to the achievement of European goals.



## EDUCATING FOR DIGITAL SUSTAINABILITY

Teachers and schools are the driving force behind the Twin Transition, transforming education through sustainable digital practices, updated curricula, and learning applied to the real challenges of the green and digital economy.

Digital transformation requires more than basic technological literacy. The Twin Transition requires the development of digital eco-skills, which combine technological mastery with environmental awareness. This means that students, teachers, and trainers must learn to:

- use digital technologies with lower energy and data impact;
- recognise the life cycle of devices and the importance of repair;
- assess the ecological footprint associated with the use of applications, storage and streaming;
- design and develop more efficient technological solutions;
- apply circular economy principles in digital processes.

Digital inclusion is also a core value. Lack of access to devices, connectivity or digital skills can lead to deep inequalities. Schools and VET centres must ensure equal conditions for all students to benefit from the Digital Transition, in line with the European Green Deal's principle of just transition.

THE DIGITAL TRANSITION IS ONLY GENUINE WHEN IT COMBINES RESPONSIBLE TECHNOLOGY, ENVIRONMENTAL AWARENESS AND INCLUSION, ENSURING SUSTAINABLE INNOVATION AND EQUAL OPPORTUNITIES FOR ALL.

## THE ROLE OF TEACHERS AND SCHOOLS IN THE TWIN TRANSITION

The impact of the Twin Transition depends on the commitment of VET schools and teachers to:

- Update curricula to include topics such as the environmental impact of ICT, responsible digital practices, and the circular economy applied to technology.
- Adopt active methodologies, such as school energy audit projects, awareness campaigns on the life cycle of digital equipment, and practical activities focused on reducing consumption and reusing resources.
- Make sustainable digital tools available for learning, promoting healthy digital habits.
- Raise students' awareness of the individual and collective responsibilities that digitalisation entails, reinforcing the link between technological choices and environmental sustainability.
- Implement internal sustainable practices, such as efficient energy management, equipment reuse, and sustainable IT policies.
- Promote project-based learning, where students develop solutions to real challenges related to the Green Deal.
- Establish partnerships with companies, aligning training with the emerging needs of the clean and digital economy.

## ACTIVE METHODOLOGIES AND PRACTICAL ACTIVITIES

To support this transformation in practice, here are some examples of activities and strategies that can be implemented in vocational schools:

1. Mapping the challenges and opportunities of the Twin Transition:

- Hold collaborative panels where students identify digital and environmental practices at school, classifying them into “green”, “digital” and “twin” categories.

2. Case studies from the European Green Deal:

- Analyse and discuss the objectives of the Green Deal, proposing concrete actions for the school or community, such as reducing waste or optimising energy consumption.

3. Personal Digital Footprint Assessment:

- Conduct a diagnostic exercise to calculate each student’s digital impact (device usage time, cloud storage, energy consumption), followed by an action plan to reduce their footprint.

4. Digital circular economy projects:

- Organise campaigns for the repair, donation and recycling of electronic equipment, promoting the extension of the life cycle of devices.

5. Debates and simulations:

- Promote debates on the risks and opportunities of digitisation, developing critical thinking on the balance between technological progress and environmental sustainability.



## TRAINING IN SUSTAINABLE DIGITAL PRACTICES

Training involves the continuous education of teachers in new methodologies and the creation of collaborative networks with companies, innovation entities, and technology centres. Encouraging interdisciplinary activities that combine technical, environmental, and digital areas is a fundamental strategy for keeping up with the demands of the market and society.

To keep pace with this transformation, education systems must ensure that everyone — teachers, trainers and students — develops the ability to:

- recognise environmental impacts associated with the use of devices and data;
- reduce your digital footprint through conscious choices;
- use digital tools that support sustainable decisions (energy monitoring, environmental simulation, circular resource management);
- create energy-efficient technological solutions;
- critically assess the benefits and risks of digitalisation.

With this approach, VET schools become learning environments that prepare citizens and professionals capable of applying good digital and environmental practices in a rapidly changing world.





## OPPORTUNITIES OF THE TWIN TRANSITION FOR VET

The convergence between sustainability and technology opens up significant opportunities for education systems. Among them:

- New areas of training: renewable energy, device maintenance, digital efficiency, circular economy, eco-design.
- Innovative learning environments: virtual laboratories, simulators, augmented reality, environmental monitoring platforms.
- Development of cross-cutting skills: problem solving, critical thinking, digital ethics and

sustainable decision-making.

- Greater connection to the world of work: companies are looking for technicians capable of responding to environmental challenges through digital solutions.

Illustrative example: the use of Digital Product Passports in sectors such as batteries or textiles. These digital passports make traceability more effective, facilitating repair, reuse and recycling — skills that VET should integrate into the training of future professionals

## RISKS AND CHALLENGES THAT SCHOOLS SHOULD CONSIDER

Despite the opportunities, the Twin Transition poses challenges that need to be incorporated into teaching:

- Energy and water consumption of digital infrastructure.
- Extraction of raw materials associated with the construction of devices.
- Increase in electronic waste and difficulties in recycling.
- Inequality in access to technology, particularly affecting rural areas or socioeconomically vulnerable students.
- Privacy and cybersecurity, with increased risks of surveillance and algorithmic discrimination.

Educating for the Twin Transition therefore means empowering students to identify, mitigate and manage these risks, making them conscious and responsible professionals.



## THE STRATEGIC ROLE OF VET IN THE TWIN TRANSITION

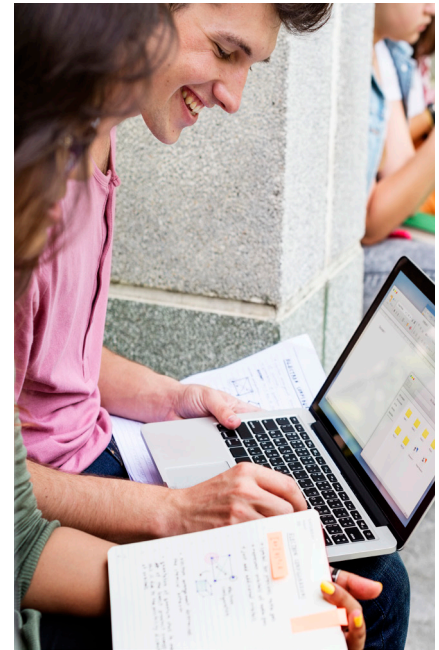
Schools and vocational training centres are ideally placed to implement the Twin Transition. To this end, they can:

- Update curricula to integrate digital eco-skills and sustainability in all technical areas.
- Establish partnerships with companies interested in green and digital practices.
- Promote interdisciplinary projects based on real problems linked to the Green Deal.
- Integrate active methodologies: project-based

learning, simulations, sustainable digital challenges, living laboratories.

- Foster responsible digital habits among students and teachers.

In doing so, they ensure that workers of today and tomorrow have the skills they need to contribute to climate neutrality and sustainable innovation.



## PATHWAYS TO ACTION: HOW TO INTEGRATE THE TWIN TRANSITION INTO TEACHING PRACTICE

To support teachers and trainers in implementing Twin Transition, it is recommended that:

- include sustainability and digitalisation as cross-cutting themes in all training units;
- adopt internal sustainable IT policies: extend the useful life of equipment, encourage repair and reduce unnecessary storage;
- use digital tools to monitor energy consumption and environmental impacts;
- propose projects in which students develop eco-digital solutions;
- encourage responsible behaviour, such as digital footprint reduction, data management and awareness of the life cycle of devices.



**The Twin Transition is inevitable and places vocational schools, teachers and students at the forefront of European change towards a sustainable and digital future. Implementing this path requires commitment, continuous updating and innovative teaching practices that link technical knowledge to environmental responsibility and digital citizenship.**

**To understand how these ideas translate into concrete practices in VET schools, see Module 2 – Good sustainability practices in VET. Digital tools and artificial intelligence at the service of sustainability are covered in Module 3, while Module 4 delves into the circular economy and sustainable digital practices in the use of devices, software and data.**

**Activity 1: Identifying the Twin Transition in everyday life**

Time: 4–5 hours

Students map daily habits associated with green, digital, and eco-digital transitions, understanding how they are interconnected.

Steps:

1. The teacher introduces the concepts of green transition and digital transition.
2. Students discuss examples from their own lives (e.g. use of renewable energy, public transport, digital tools in learning).
3. In groups, they map which examples belong to the “green transition”, which to the “digital transition” and which show a “double transition”.
4. Each group presents their map on a flipchart.

Outcome: Students understand that the dual transition is not abstract, but is linked to everyday choices and practices.

**Activity 2: School and the European Green Deal**

Time: 3 hours

Students analyse Green Deal targets and propose concrete actions for the school to support the transition, linking European policies to the local context.

Steps:

1. Students receive a simple leaflet outlining the main objectives of the European Green Deal.
2. In small groups, they select 2-3 objectives and discuss how the school could contribute to them (e.g. reducing energy consumption, circular practices, more efficient digital habits).
3. The groups prepare a poster with concrete proposals for the school.
4. The posters are displayed in an exhibition in the classroom.

Result: pupils relate the EU’s political objectives to actions at local and school level

**Activity 3: Calculate and reduce your digital footprint**

Time: 4–5 hours

Students assess their digital impact (streaming, stored data, device usage) and create reduction recommendations.

Steps:

1. The teacher explains the concept of digital footprint (energy, water and material impacts of data).
2. Students estimate their own digital footprint: hours of streaming per week, emails stored, time spent using devices.
3. Each group compares the results and discusses ways to reduce the impact.
4. Together, the class drafts the “10 main rules for reducing our digital footprint”.

Result: students relate digital habits to environmental impact and propose concrete behavioural changes

**Activity 4: Debate on Twin Transition priorities**

Time: 3–4 hours

Teams discuss the benefits and risks of digitalisation and sustainability, developing critical thinking and a balanced perspective.

Steps:

1. The class is divided into two groups: one arguing that “digitalisation brings more benefits than risks” and the other arguing that “ecological priorities must always come first”.
2. The teams prepare their arguments for 30 minutes.
3. A structured debate is held, moderated by the teacher.
4. The class reflects on the need to balance both transitions.

Result: students develop critical thinking, recognising both the opportunities and risks of the dual transition.





## MODULE 2

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# GOOD PRACTICES FOR SUSTAINABILITY IN VET

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SUSTAINABILITY IS NOW RECOGNISED NOT ONLY AS A POLITICAL AND ENVIRONMENTAL PRIORITY, BUT AS A PRACTICAL NECESSITY THAT SHAPES THE WAY PEOPLE LIVE, WORK AND LEARN. IN VOCATIONAL EDUCATION AND TRAINING (VET), SUSTAINABILITY GOES BEYOND ABSTRACT PRINCIPLES: IT MEANS PREPARING LEARNERS TO BE RESPONSIBLE PROFESSIONALS AND ACTIVE CITIZENS CAPABLE OF SUPPORTING THE GREEN AND DIGITAL TRANSITION – THE SIMULTANEOUS AND COMPLEMENTARY TRANSFORMATION OF EUROPEAN SYSTEMS TOWARDS CLIMATE NEUTRALITY AND DIGITAL INNOVATION.

THIS MODULE PROVIDES GUIDANCE, RESOURCES AND GOOD PRACTICES FOR VET TEACHERS AND TRAINERS TO SUCCESSFULLY INTEGRATE SUSTAINABILITY AND DIGITAL SKILLS INTO THEIR TEACHING PRACTICES. IT EXPLORES ACTIVE METHODOLOGIES AND PRACTICAL ACTIVITIES THAT HELP TEACHERS WORK ON CROSS-CUTTING THEMES SUCH AS THE ENVIRONMENTAL IMPACT OF TECHNOLOGIES, THE CIRCULAR ECONOMY, SUSTAINABLE DIGITAL TOOLS AND ENVIRONMENTAL AWARENESS. AT THE SAME TIME, IT ALIGNS WITH THE OBJECTIVES OF THE EUROPEAN GREEN DEAL AND PROMOTES THE EMPOWERMENT OF TEACHERS, TRAINERS AND STUDENTS TO UNDERSTAND AND APPLY SUSTAINABLE DIGITAL PRACTICES IN BOTH EDUCATIONAL AND PROFESSIONAL CONTEXTS.

## THE GREEN AND DIGITAL TRANSITION: CONCEPT AND STRATEGIC RELEVANCE

### WHAT IS THE GREEN AND DIGITAL TRANSITION?

The Twin Transition combines the green transition and the digital transition that Europe is undergoing. The green transition focuses on reducing emissions, renewable energy, the circular economy and environmental protection, while the digital transition integrates technologies such as AI, automation and cloud computing across all sectors.

The innovation lies in the fact that these two transitions reinforce each other: digital technologies help achieve environmental goals, and sustainability ensures that digitalisation follows ethical and responsible principles. Together, they drive a more sustainable, efficient and balanced future.

## WHY IS IT ESSENTIAL FOR THE FUTURE OF VOCATIONAL EDUCATION?

The importance of sustainability in VET cannot be underestimated. Modern economies are under pressure to reduce carbon emissions, decrease resource use and move towards a circular model, in which products are repaired, reused and recycled. At the same time, the digital transition is transforming how work is done, how services are delivered and how societies communicate. These processes are not separate: the digital and green transitions reinforce each other in the twin transition.

For students, sustainability is more than just an additional subject. It must be incorporated into all subjects. An electrician learning to install solar panels must also understand how to connect them to smart grids and how to advise customers on energy efficiency. An automotive student must learn about electric vehicles and the digital systems that manage batteries and charging stations. An IT student should be aware of how data centres consume energy and how coding practices can influence the lifespan of hardware. Even in areas such as hospitality or healthcare, sustainability is important: sourcing food responsibly, reducing waste, or using digital records to protect privacy and minimise paper consumption.

When VET integrates sustainability into its teaching, students become agents of change. They bring sustainable practices to their workplaces, influence their employers, and set an example for their families and communities. This creates a multiplier effect: small actions taken by many professionals together contribute to achieving the ambitious goals of the European Green Deal.

The relevance of the Green and Digital Transition to VET is fundamental for several reasons:

**Labour Market Transformation:** Traditional sectors are evolving rapidly. Today's electrician must

understand solar panels and smart grids; an automotive technician must master electric vehicles and digital battery systems; an IT professional must be aware of the environmental impact of data centres and efficient coding. VET has a responsibility to prepare its learners for these emerging realities.

**Creating Career Opportunities:** The green and digital economy is generating thousands of new skilled jobs. According to European studies, the renewable energy, energy efficiency, circular economy and clean technology sectors are among the fastest growing. VET graduates with skills in both areas are better positioned for employment and career advancement.

**Institutional Responsibility:** Vocational training schools serve their local communities and prepare professionals who will shape the future. They have a special responsibility to demonstrate that sustainability is viable, advantageous and achievable. When a VET school integrates sustainable practices into its operations and curricula, it acts as a living laboratory, showing learners that change is possible and that they can be agents of that transformation.

**Alignment with European Policies:** The European Green Deal and the Digital Education Action Plan set ambitious goals for the whole of Europe. VET institutions that align themselves with these goals not only fulfil European policy obligations, but also position themselves as innovative and responsible institutions, attracting learners, business partners and funding.



## THE EUROPEAN GREEN DEAL AND THE ROLE OF SCHOOLS AND TEACHERS

### Main Objectives of the European Green Deal

The European Green Deal, approved in 2019 and further developed in 2023, is the European Union's sustainable development strategy. Its main objectives include:

**Climate Neutrality by 2050:** Europe commits to achieving net-zero carbon emissions by 2050, with an interim target of reducing emissions by 55% by 2030 (compared to 1990 levels).

**Circular Economy and Resource Efficiency:** promoting the transition from a linear model of production and consumption (produce use dispose) to practices that avoid waste and maximise the reuse, repair and recycling of materials. This concept is explored in greater depth, applied to the digital context, in Module 4: Circular Economy and Sustainable Digital Practices.

**Biodiversity and Environmental Protection:** Restoration of ecosystems, protection of forests, seas and soils, and reduction of air and water pollution.

**Innovation and Sustainable Investment:** Mobilising hundreds of billions of euros in financing for clean technologies, green infrastructure and skills development. The European recovery fund (NextGenerationEU) allocates substantial resources to the green and digital transition.

**Social Justice and Inclusion:** Ensuring that the transition benefits all citizens and regions, leaving no one behind. This includes support for workers in declining sectors and equitable access to training and green job opportunities.

**Global Leadership:** Positioning Europe as a model of sustainability and influencing other regions of the world to adopt similar commitments.

### The Role of VET Schools

Schools and vocational training centres are key players in implementing the European Green Deal. Their role is multidimensional:

**Preparing a skilled workforce:** Achieving European climate goals requires millions of professionals with skills in clean technologies, energy efficiency, the circular economy and sustainable digitalisation. VET is responsible for providing this workforce. Courses must be updated to include content on renewable energy, building retrofitting, regenerative agriculture, waste management, green IT and many other areas.

**Education for Environmental Citizenship:** In addition to specific vocational training, schools must develop a deep understanding of environmental challenges and a mindset of responsibility in their students. Students should learn to analyse complex systems, anticipate consequences, think critically about trade-offs, and collaborate on solutions. This is the essence of sustainability literacy.

**Demonstration of Sustainable Practices:** VET schools should "lead by example". A school that reduces its energy consumption, implements a circular economy policy for IT equipment, manages water and waste responsibly, and uses sustainable transport demonstrates that sustainability is achievable. This has a powerful educational effect: students see, experience, and internalise that change is possible.

**Partnerships with Businesses and Communities:** VET schools are points of contact between the education system, the labour market and local communities. They can catalyse the adoption of sustainable practices by establishing partnerships with businesses (e.g. through internships and apprenticeships with sustainability objectives), collaborating with local authorities on community projects and involving

trainees' families in awareness-raising initiatives.

**Pedagogical Innovation:** VET schools have the opportunity to experiment with new teaching and learning methodologies that promote sustainability. This includes project-based learning, solving authentic real-world problems, design thinking, experiential learning and the responsible use of digital tools to enhance teaching.

### The Role of Teachers and Trainers

Teachers and trainers are the most direct link between the European Green Deal and trainees. Their role is crucial:

**Facilitators of Integrated Knowledge:** Teachers must be able to integrate sustainability content into their subjects in a relevant and contextualised way. A teacher of electrical installations does not teach "sustainability" in a generic way, but integrates knowledge about renewable energy systems, energy efficiency and smart grids into their everyday professional practice.

**Models of Responsible Behaviour:** Teachers demonstrate through their daily actions how to live and work sustainably. Using public transport or bicycles, minimising printing, practising "digital sobriety", separating waste, repairing equipment instead of replacing it – these actions have an educational impact.

**Project Mentors:** Trainers can guide projects where students identify and solve real sustainability problems in their schools and communities. This experiential learning is deeply formative.

**Bridge between Education and Profession:** Teachers should help students understand that digital sustainability skills are not optional extras to their professional qualifications, but core elements of future professional success.



## GOOD PRACTICES FOR INTEGRATING SUSTAINABILITY AND DIGITAL SKILLS IN VET

### SUSTAINABILITY IN PROFESSIONAL ENVIRONMENTS

Schools and VET centres should be models of sustainability. Good practices include:

#### At the Institutional Level

**Green Campus Strategy:** Set clear and measurable goals for energy reduction, waste management, sustainable mobility, and responsible use of digital resources. For example, a goal to reduce energy consumption by 30% in 3 years, or to recycle 80% of waste produced.

**Extending the Life Cycle of IT Equipment:** Instead of constantly replacing devices, schools should:

- Use refurbishment services
- Look for second-hand markets for equipment that is still functional
- Establish donation programmes for schools and organisations with fewer resources
- Train staff in basic maintenance to extend the useful life of equipment

**Sustainable Procurement Policies:** Give preference to suppliers who comply with environmental and social standards, such as the use of renewable energy in production, guarantees of fair working conditions, and minimal and recyclable packaging.

**Waste Management and Circular Economy:** Implement selective waste collection systems, composting of organic matter (especially relevant in centres with canteens), and repair and reuse programmes.

#### At the Curriculum Level

Sustainability should not be an optional module, but a common thread running through all courses. Examples of curriculum integration:

- **Electrical Engineering Students:** Installing and maintaining solar panels, understanding smart grids, calculating energy efficiency of systems.
- **Culinary/Hospitality Students:** Local and seasonal sourcing of ingredients, reducing food waste, responsible water management, composting.

- **IT Students:** Code efficiency, environmental impact of data centres, data privacy and digital security, digital sobriety.

- **Automotive Mechanics Students:** Electric vehicles, battery systems, parts recycling, digital diagnostics to reduce fuel consumption.

- **Logistics students:** Route optimisation to reduce emissions, circular economy in inventory management, digital platforms for efficiency.

Project-based learning is particularly effective. Working in teams, students identify real sustainability problems in their school or community and develop creative solutions, applying technical knowledge and innovation.

#### At the Partnership Level

Collaborations with companies, local authorities and organisations ensure that the skills developed are relevant to the labour market. Examples:

- **Internships with sustainability goals:** Graduates work in companies on specific projects related to carbon reduction, the circular economy, or green digitalisation.

- **Integrated learning:** Combining classroom training with practical experience in real contexts where sustainability is implemented.

- **Community collaboration:** Partnerships with local authorities for projects related to energy efficiency, urban cleaning, sustainable mobility, etc.

#### Competency Benchmarks: The GreenComp Model

GreenComp, launched by the European Commission in 2022, defines sustainability skills for learners of all ages. The model is structured around four domains:

1. **Systemic Thinking:** Understanding complex systems (natural, social, technical) and their interconnections.

2. **Future Literacy:** Ability to imagine alternative future scenarios, anticipate consequences of decisions,



and plan for the long term.

3. **Critical Thinking and Analysis:** Questioning assumptions, evaluating information, understanding trade-offs and conflicts of interest.

4. **Transformative Action:** Ability to act effectively to promote positive change, working collaboratively, communicating ideas, influencing policy.

VET schools that align their curricula with GreenComp ensure that their graduates acquire not only technical knowledge, but also the sustainability mindset necessary to contribute to the green and digital transition in the long term.

### Sustainability in Personal Environments

Sustainability is not just the responsibility of institutions; individuals, through their everyday choices, also shape the green and digital transition.

#### Digital Sobriety

Digital technologies seem immaterial, but they have a significant environmental footprint. Storing data in the cloud, watching high-definition films, keeping thousands of photographs, leaving devices on standby – all of this consumes energy, water and materials extracted from the earth.

Digital Sobriety practices that teachers and trainees can adopt:

- Regularly delete unnecessary files, old emails, unused applications
- Reduce video resolution when appropriate
- Turn off cameras during unnecessary video conferences
- Clear browsing history and cookies regularly
- Use dark mode on devices (reduces energy consumption)
- Question when it is really necessary to record a meeting or send attachments

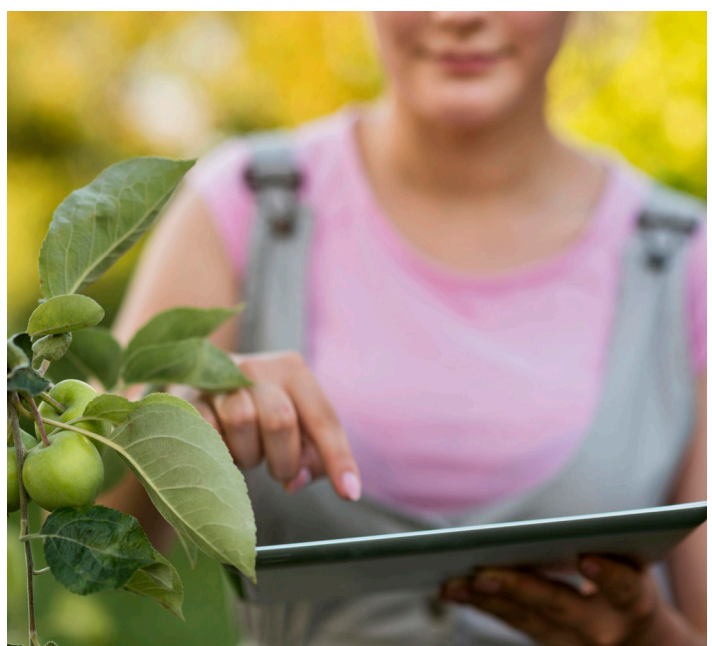
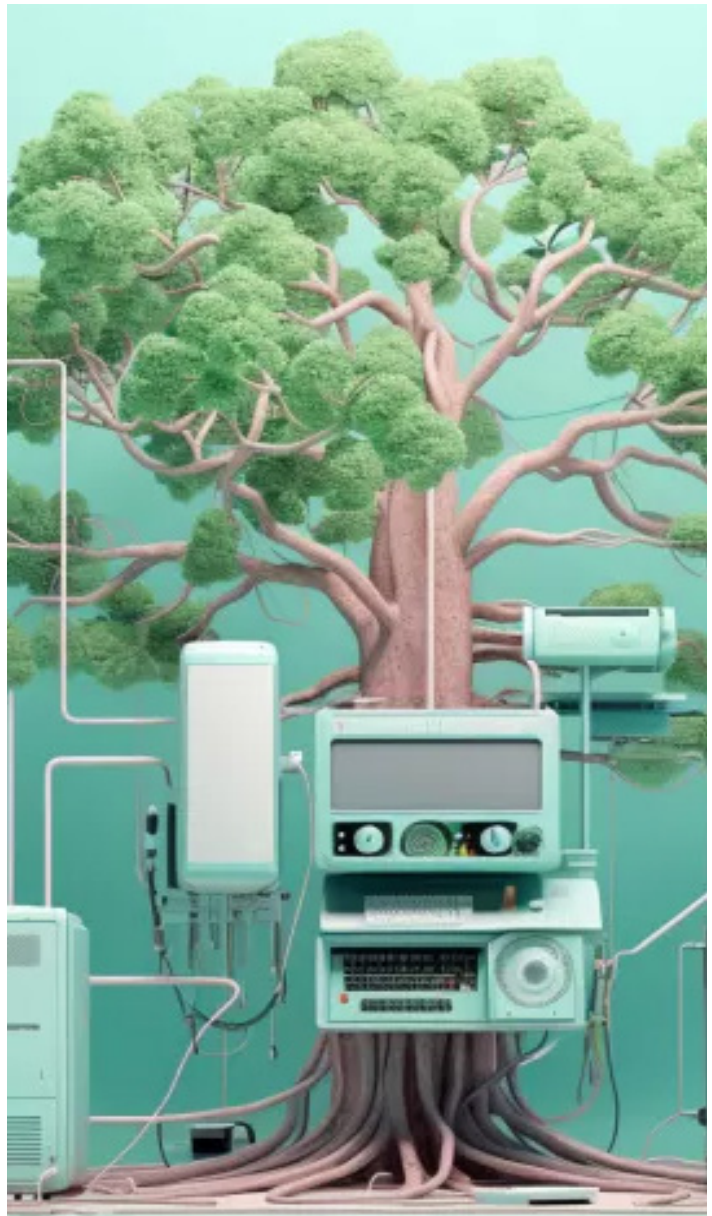
Digital Cleanup Day, celebrated annually in March, is an educational opportunity to raise awareness among students about this topic. By deleting unnecessary files, participants not only reduce their own impact, but also collectively contribute to reducing demand for storage in data centres, saving energy globally.

#### Responsible Consumption and Circular Economy

In this module, the circular economy is addressed mainly through examples of responsible consumption and extending the life cycle of equipment, both in a personal and institutional context. For a detailed definition of the concept and its specific application to digital technology, see Module 4: Circular Economy and Sustainable Digital Practices.

The culture of constant upgrading – buying the latest mobile phone or computer even when the previous one still works – increases the volume of electronic waste and resource extraction. Responsible practices include:

- Repair instead of replacement: Learn how to repair simple devices, seek professional repair services, use



compatible parts.

- Purchase refurbished products: Second-hand mobile phones, computers, and peripherals work perfectly and have a significantly lower environmental footprint.

- Extended life cycles: Keep equipment as long as it works, protect it with covers and preventive care.

- Responsible donation: When a device is no longer useful, donate it to schools or organisations instead of discarding it.

### Sustainable Mobility

Daily commutes have a direct environmental impact. Sustainable alternatives include:

- Walking or cycling for short journeys
- Using public transport
- Carpooling (sharing a car with colleagues)
- Teleworking/telestudy where possible
- Holidays and business travel with fewer long-haul flights

Digital platforms can support these habits: route planning apps, bike-sharing services, integrated public transport tickets.

### Circular Economy in Everyday Life

Individuals can apply circular economy principles through concrete actions in their daily lives (the fundamentals and connection to the digital world are explored in depth in Module 4). Some examples include:

- Donation: Clothes, books, furniture, and other items that are no longer used can have a second life

- Repair: Appliances, utensils, furniture – many things can be repaired instead of discarded

- Community initiatives: Participate in exchange groups, repair cafés, community composting programmes, environmental clean-ups

### Implementation of Sustainable Digital Practices in VET

Digital technology is an essential tool for achieving sustainability, but only if implemented responsibly.

### Cloud Computing Policies

Schools should establish clear policies for cloud usage:

- Avoid duplication: Collaborative platforms with version control (Google Workspace, Microsoft 365, NextCloud) reduce the need for multiple copies.

- Time limit for data: Establish appropriate retention periods; old data should be archived, compressed, or deleted.

- Supplier selection: Look for cloud providers that use renewable energy and have sustainability certifications.

### Data Management Skills Development

Students must learn when and how:

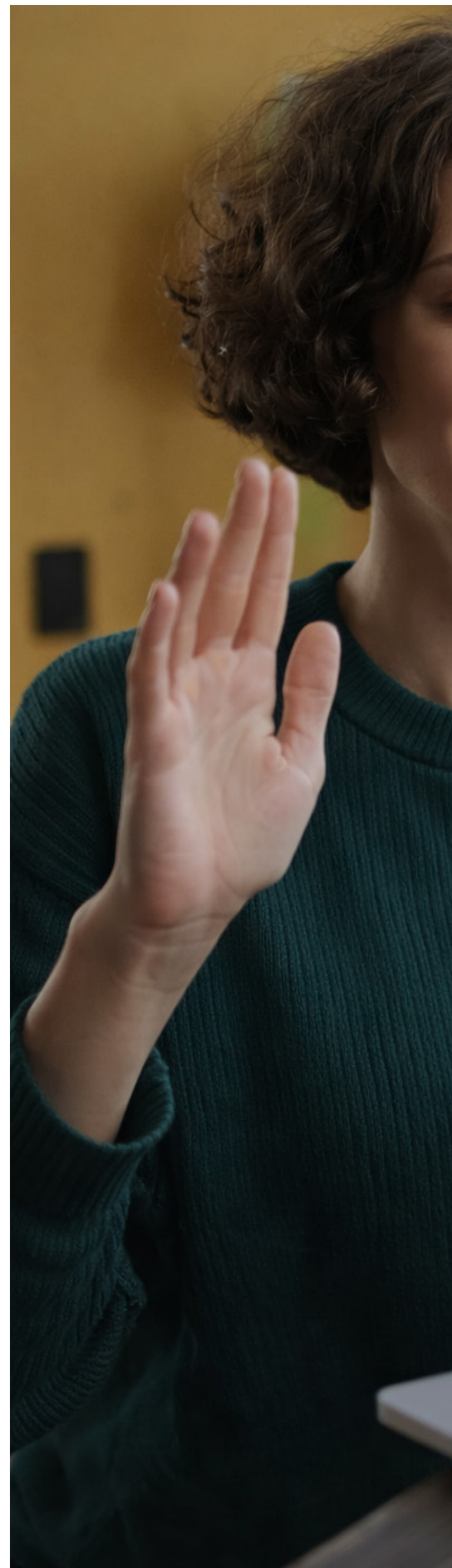
- Archive: Data with historical value but infrequent access
- Compress: Reduce file size without losing essential quality
- Delete: Identify and delete truly unnecessary data

This reduces the environmental footprint of digital storage and improves operational efficiency.

### Energy Awareness in Videoconferencing and Streaming

Awareness campaigns can promote:

- Turning off cameras when not essential
- Audio-only mode for meetings that do not require video
- Selective recording (not recording everything “just in case”)
- Reduction of unnecessary streaming (music, films paused for hours)





### Integration of Repair and Reconditioning Skills

IT and Electronics programmes should include skills in:

- Diagnosing equipment problems
- Repairing common components
- Refurbishing devices
- Responsible recycling of non-repairable components

This enables trainees to contribute directly to the circular economy and offers employment opportunities in a growing sector.

### Environmental Impact Monitoring and Assessment

Digital tools can be used for:

- Carbon footprint calculation: Software that calculates the impact of school operations, student projects, or career choices.
- Data analysis: Using artificial intelligence and data analysis to identify opportunities for energy savings and process optimisation.
- Transparent communication: Dashboards and reports that show progress towards sustainability goal.

### The Climate Neutral Data Centres Pact Initiative

As an example of the possibility of sustainable digitisation at scale, more than 40 large European companies have committed to making all data centres carbon neutral by 2030, using 100% renewable energy and implementing advanced cooling technologies. For graduates entering the IT and engineering sectors, this sets a standard of professional responsibility and demonstrates that digital sustainability is achievable on a large scale.

## BUILDING A CULTURE OF SUSTAINABILITY AT VET

True transformation does not result from isolated projects, but from the development of an institutional culture of sustainability, where environmental and social responsibility become part of the school's identity and values.

### Leadership and Governance

**Integration into the Institutional Mission:** Sustainability must be explicitly reflected in the school's mission statement, vision and values.

**Resource Allocation:** Dedicated budgets for sustainability initiatives, staff training, investment in infrastructure (solar panels, selective waste collection, etc.).

**Governance Structure:** Sustainability committee with representation from teaching staff, non-teaching staff, students, families and potentially external partners. This committee sets goals, monitors progress and



identifies challenges.

### Involvement and Participation

A culture of sustainability is not imposed from the top down, but co-constructed through genuine participation:

Teaching staff: Continuous training in sustainability content, sharing innovative practices, time dedicated to integrating sustainability into the curriculum.

Non-teaching staff: Recognition of their essential role (security, cleaning, maintenance, administration) and active participation in decisions that affect the school's sustainability.

Students: Leadership through sustainability clubs, awareness campaigns, participation in project design, representation in governance structures.

Families and Community: Regular communication about initiatives, invitations to participate in events, dialogue about how the school and families can collaborate.

### Critical Thinking and Systems Awareness

Sustainability is complex. Decisions that benefit one aspect may harm another. For example:

- Renewable energy is essential, but solar panels require materials that have an environmental impact
- Cloud computing may be more energy efficient than maintaining local servers, but it centralises data
- Cycling is sustainable, but not everyone can ride a bicycle (pregnant women, people with reduced mobility)

Trainees should be empowered to:

- Analyse trade-offs: Understand that every action has benefits and costs
- Holistic thinking: See systems as interconnected (environmental, social, economic, technological)
- Adaptability: Be prepared for emerging challenges, change strategy when appropriate, learn continuously

This is the essence of resilience, a key competence for both the green and digital transitions.

### Recognition and Celebration

Publicly recognise efforts and successes:

- Celebrate milestones (e.g., 'We reduced carbon emissions by 20%')
- Give visibility to students and teachers who are leaders in sustainability
- Share impact stories (success stories, transformations)
- Send progress reports to the community

### References: The Eco-Schools Programme

Eco-Schools, present in more than 60 countries, offers a structured framework for integrating sustainability into everyday school life. The programme invites schools to:

1. Audit their current environmental situation
2. Involve the entire school community in identifying areas for improvement
3. Implement concrete projects and actions
4. Monitor and communicate progress
5. Apply for recognition (green flag)

Some European VET schools have successfully joined Eco-Schools, implementing initiatives such as:

- Monitoring energy consumption
- Reducing food waste
- Biodiversity projects (gardens, nesting boxes)
- Integrated environmental education programmes

## FROM KNOWLEDGE TO ACTION

**The Green and Digital Transition is a European and global imperative. It is not just an abstract political or environmental goal, but an everyday reality that shapes how people work, live and learn. Vocational education and training schools, with their practical focus and direct links to labour markets, are uniquely positioned to accelerate this transformation.**

**Activity 1: Mapping Sustainable Practices in VET Environments**

Time: 3-4 hours

Objective: Enable students to identify, analyse, and classify sustainability practices already present in their VET school and training workshops, connecting institutional actions with the Green and Digital Transition.

Description: The teacher introduces the concept of sustainability in VET institutions, focusing on energy, waste, digital use, mobility, and equipment management.

Students are divided into small groups and asked to explore different areas of the school (classrooms, workshops, computer rooms, common spaces).

Each group maps existing practices into categories:

- Energy efficiency
- Waste management and recycling
- Digital practices (printing, cloud use, device management)
- Circular economy (reuse, repair, donation)
- Sustainable mobility

Groups identify:

- Practices already in place
- Practices that could be improved
- Practices that are missing

Each group prepares a visual map (poster or digital board) summarising their findings.

Outcome: Students understand sustainability as a concrete and observable reality within their learning environment, not an abstract concept.

**Activity 2: Designing a Sustainable VET Classroom or Workshop**

Time: 4-5 hours

Objective: Encourage students to apply sustainability principles by redesigning a classroom or workshop using realistic and achievable solutions.

Description: The teacher presents examples of sustainable practices in VET settings (energy saving, circular use of equipment, digital sobriety).

In groups, students select a real classroom or workshop they use regularly.

They analyse:

- Energy consumption (lighting, devices, standby use)
- Material use (paper, consumables, tools)
- Digital habits (printing, file storage, software use)
- Equipment lifecycle (repair vs replacement)

Each group designs a “Sustainable Classroom Plan” including:

- At least 5 concrete actions
- Estimated environmental benefits
- Roles and responsibilities (students, teachers, institution)

Plans are presented and discussed with the class.

Outcome: Students develop problem-solving skills and understand how sustainability can be integrated into daily professional environments.

**Activity 3: Digital Sobriety and Responsible Technology Use**

Time: 3-4 hours

Objective: Raise awareness about the environmental impact of everyday digital practices and promote responsible digital behaviour.

Description: The teacher explains the concept of digital sobriety and its relevance to sustainability.

Students individually analyse their digital habits:

- Number of devices used
- Time spent online
- Printing habits
- Cloud storage and file duplication

In small groups, students compare habits and identify:

- High-impact behaviours
- Simple changes with significant benefits

The class collaboratively creates a “Digital Sobriety Charter for VET Students” with practical rules (e.g. reduce unnecessary printing, regular file clean-ups, responsible use of video).

Outcome: Students connect personal digital behaviour with environmental impact and adopt realistic improvement strategies.





## MODULE 3

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# DIGITAL TOOLS FOR SUSTAINABILITY

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MODULES 1 AND 2 PRESENTED THE FRAMEWORK FOR THE GREEN AND DIGITAL TRANSITION, THE ENVIRONMENTAL IMPACT OF DIGITAL TECHNOLOGIES, AND VARIOUS PRACTICES FOR RESOURCE SOBRIETY AND RESPONSIBLE MANAGEMENT. THIS MODULE 3 DELVES DEEPER INTO THESE TOPICS WITH A SPECIFIC FOCUS ON ARTIFICIAL INTELLIGENCE (AI) AND HOW IT CAN BE BOTH PART OF THE PROBLEM AND PART OF THE SOLUTION.

THE AIM OF THIS MODULE IS TO EXPLORE THE USE OF NEW AI TOOLS TO IMPROVE OUR SUSTAINABILITY IN VOCATIONAL EDUCATION AND TRAINING (VET). WE WILL ANALYSE THE MAIN AREAS IN WHICH AI CAN BE USED IN THE CONTEXT OF VET: AI ITSELF (MODELS AND TOOLS), ENERGY CONSUMPTION, ELECTRONIC WASTE, AND THE CIRCULAR ECONOMY AND REPAIR.

THROUGHOUT THE CHAPTER, WE PRESENT EXAMPLES AND IDEAS FOR ACTIVITIES THAT CAN BE DEVELOPED WITH STUDENTS. AS A TEACHER, THESE PROPOSALS SHOULD BE DEVELOPED AND ADAPTED TO THE SCHOOL CONTEXT, AVAILABLE RESOURCES AND CLASS LEVEL.

## THE DUAL ROLE OF AI IN SUSTAINABILITY

Artificial Intelligence (AI) plays a complex and sometimes contradictory role in environmental sustainability. On one hand, AI systems—particularly large-scale machine learning models—consume vast amounts of energy, contributing to carbon emissions and electronic waste. On the other hand, AI-driven solutions are being used to optimize energy use, reduce waste, and improve efficiency across multiple industries, making it a powerful tool in the fight against climate change.

### The Environmental Cost of AI

One of the biggest criticisms of AI is its high energy consumption, particularly during the training phase of deep learning models. For example, training a single advanced natural language processing model like GPT-3 can emit as much as 552 metric tons of CO<sub>2</sub>—equivalent to the annual emissions of 120 gasoline-powered cars. This energy demand stems from the massive computational power required, often relying on data centers that account for nearly 1% of global electricity use. Additionally, AI hardware, such as specialized GPUs and TPUs, depends on rare minerals, contributing to resource depletion and e-waste when devices become obsolete.

Read more:

- Nature Magazine Article: <https://www.nature.com/articles/d41586-025-01113-z>
- A blog article "Using ChatGPT is not bad for the environment": <https://andymasley.substack.com/p/individual-ai-use-is-not-bad-for>



## AI as a Force for Sustainability

Despite its energy demands, AI is increasingly being leveraged to reduce environmental harm. In energy management, AI optimizes smart grids by predicting electricity demand and integrating renewable energy sources more effectively. Google's DeepMind, for instance, reduced the energy used for cooling its data centers by 40% through AI-driven efficiency improvements.

In agriculture, AI enables precision farming by analyzing soil conditions, weather patterns, and crop health, allowing farmers to minimize water and pesticide use. IBM's Watson Decision Platform for Agriculture is one example of how AI helps optimize food production while reducing environmental strain.

Transportation is another area where AI contributes to sustainability. Logistics companies like UPS use AI-powered route optimization to cut fuel consumption, saving millions of gallons of diesel annually. Meanwhile, AI enhances the efficiency of electric vehicles by optimizing battery performance and charging networks.

AI also plays a role in reducing e-waste and promoting a circular economy. Predictive maintenance systems, such as those used by Siemens, extend the lifespan of industrial machinery by detecting failures before they occur. In recycling, AI-powered robots like Apple's Daisy disassemble discarded electronics to recover valuable materials, reducing the need for new resource extraction.

Read more:

- IEA Study: <https://www.iea.org/reports/energy-and-ai>

- MIT criticism about IEA Study: <https://www.technologyreview.com/2025/04/10/1114912/why-the-climate-promises-of-ai-sound-a-lot-like-carbon-offsets/>

## USING AI TO REDUCE ENERGY CONSUMPTION

### Energy of cloud for LLMs

AI optimizes energy usage in computing systems through techniques like Dynamic Voltage and Frequency Scaling (DVFS), where AI adjusts processor power dynamically, reducing waste. Another method is Energy-Aware Scheduling, where ML models optimize task distribution in data centers, considering efficiency, utilization, and cooling, leading to significant energy savings.

Sources: Power Electronic Tips, IEEE.

AI boosts energy efficiency via model optimization (quantization, pruning), shrinking AI models by up to 75% with minimal accuracy loss—key for edge devices. However, AI itself consumes energy. Free LLMs still cost energy (paid by premium users/data). We can reduce the consumption:

- Reducing usage and opting for smaller models when possible.
- In APIs, choosing smaller, cheaper models for simple tasks saves energy and costs.

Efficient AI requires both smarter tech and mindful usage. If we are programming

a Wrapper for a LLM, we use the API and pay for a quantity of tokens. Some commercial AI LLMs like OpenAI let us choose the model. If the task is not difficult, small models can solve it and reduce energy and our bill, because tokens are cheaper.

### Classroom Activity:

This activity is about choosing the right model to spend less money and energy. It will need some preparation of the environment by the teachers.

This python code is a simple way to call a LLM:

```
import openai
openai.api_key = "your-api-key-here"
def ask_llm(prompt, model="gpt-3.5-turbo"):
    response = openai.ChatCompletion.create(model=model, messages=[{"role": "user", "content": prompt}])
    return response.choices[0].message["content"]

# Example usage:
print(ask_llm("Summarize the Industrial Revolution.", model="gpt-3.5-turbo"))
# or use model="gpt-4" if needed
```

Using GPT 3.5 Turbo is better than GPT-4 in terms of energy and price and maybe you cannot notice the difference.

You can do the same with Gemma and Gemini models:

```
import google.generativeai as genai
import os

genai.configure(api_key=os.environ.get("GOOGLE_API_KEY"))

def ask_llm(prompt, model_name="gemini-1.5-flash"):
    model = genai.GenerativeModel(model_name)
    response = model.generate_content(prompt)
    return response.text

summary = ask_llm("Summarize Industrial Revolution.", model_name="gemini-1.5-flash")
print(summary)
```

## Energy of self hosted LLMs

To self host a LLM is interesting because you have control of your data, you can use less energy and reduce the bill of Cloud based LLMs.

Software like vLLM is very powerful for enterprise solutions, but you can run an LLM on your own PC. We recommend <https://ollama.com/> and there are many other solutions.

### Classroom Activity:

- Discuss about running your own LLM, Hardware needed for servers, PC limitations and benefits.
- Download and install Ollama on a computer with GPU. Download the biggest model your computer can run



and one of the smallest. For example: Gemma 3 27B and Gemma 3 1B.

- Run some questions for each one and compare the time that lasts and the quality of the results.
- You can monitor the energy consumption with software (depends of your operating system) or, more interesting, with a physical Plug in Power Meter
- Make some tables and graphs of consumption and calculate the energy bill with the current tariffs.

## Key Areas Where AI Reduces Energy Consumption

AI optimizes energy use in buildings via smart HVAC and lighting systems that adapt to real-time conditions. (<https://www.sciencedirect.com/science/article/pii/S1359431123012826>)

For renewable grids, AI predicts energy generation and demand while optimizing battery storage, enabling more efficient and sustainable power management. Additionally, AI-driven battery management systems optimize charge/discharge cycles in grid-scale storage, maximizing efficiency and extending battery lifespans.

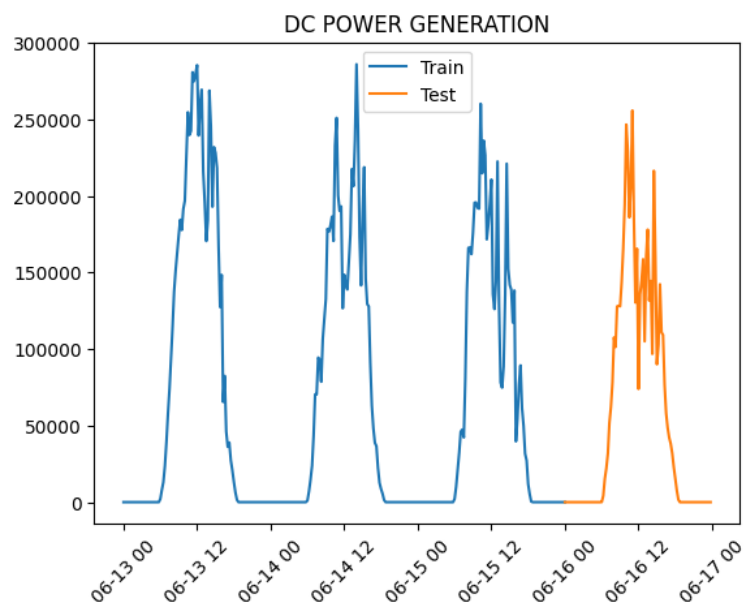
### Classroom Activity:

In Kaggle there are many data analyses about energy production and consumption. In class, you can open and clone one and start working on it. It's very difficult for a medium level VET to make it from 0, but to understand and modify it should be possible. For example:

<https://www.kaggle.com/code/sedimir/machine-learning-forecasting-power-generation>

Once studied and after a class discussion, students will know the existence of this type of tools to analyze data and these free libraries to predict.

To support these experiences with real data and encourage students to reflect on their own digital consumption, the activities in this module can be combined with the Sustainable Digital Diagnosis and personal digital sobriety plan proposed in Module 4.



## USING AI TO REDUCE E-WASTE

AI is tackling e-waste by enabling predictive maintenance to extend device lifespans, like Siemens' industrial AI that anticipates equipment failures before they occur ([Business Insider, 2024](#)); Powering smart recycling robots for efficient material recovery, such as Apple's Daisy robot ([Apple Newsroom, 2018](#)) and optimizing circular economy models through supply chain analysis. For vocational education students in technical fields, AI-powered solutions offer exciting opportunities to address this crisis while developing valuable green tech skills.

## Classroom Activity:



This activity can be done with a laptop or a PC with Webcam, but it is more interesting to do with a Raspberry Pi 4/5 and a camera module.

Students can deploy a pretrained waste-detection model, process live camera input to identify e-waste categories like circuit boards and plastics, and analyze results to optimize recycling accuracy. The exercise requires Python 3.9+ with key libraries (`ultralytics` for YOLOv8 and `streamlit` for the interactive interface).

<https://github.com/teamsmcorg/Waste-Classification-using-YOLOv8>

### Additional ideas:

- This project has some challenges like the size of the model and libraries or the power of the CPU.
- You can create a case with the camera and a small screen to hang on a wall of the VET Classroom and use it to classify e-waste.



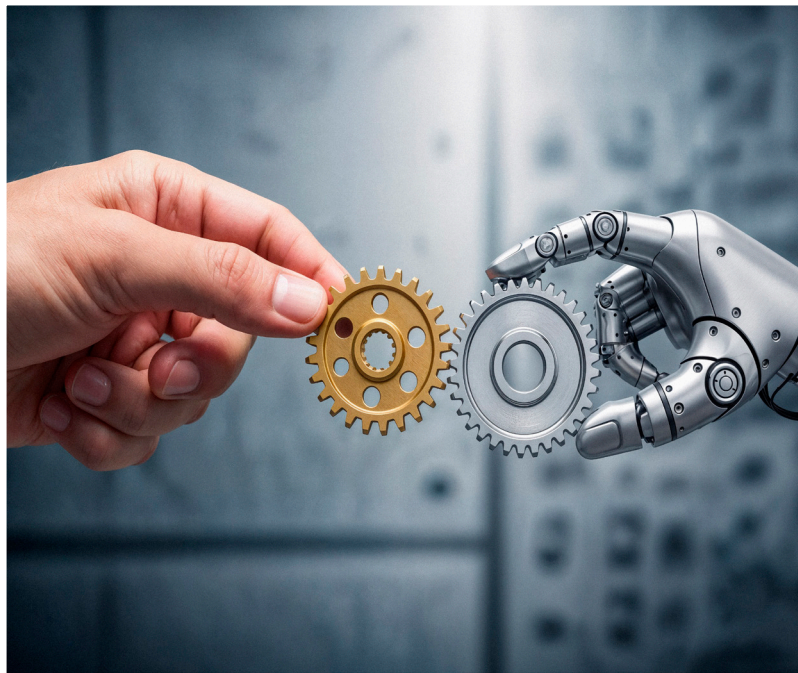
- You also can add some robotics concepts if you add a servo that moves the e-waste to the correspondent recycling bin.



The ideas developed here, focused on the use of AI to support the reuse, repair, and recycling of equipment, complement the broader framework of the circular economy in the digital sector presented in Module 4, which also offers specific activities for managing the school's technology park.

Artificial Intelligence can be a powerful tool in combating e-waste, but the real challenge begins when we decide how to use it. The technology already exists to extend the life of equipment, improve recycling, and reduce environmental impact — the question is: are we ready to turn it into action?

Now the challenge is yours. The limit is not in the code, the hardware or the available resources, but in your imagination. Can you create an AI solution that reduces e-waste? A system, a prototype, an idea? The technology is at your fingertips. The next step is up to you.



## AI FOR CIRCULAR ECONOMY & REPAIR

AI-powered diagnostic chatbots can help consumers repair devices instead of discarding them by guiding users through troubleshooting and suggesting fixes. For example, an AI assistant could analyze uploaded photos to identify faulty components and provide step-by-step repair instructions, while also recommending compatible refurbished parts from trusted suppliers.

Additionally, AI can match devices with optimal refurbished parts by cross-referencing models and sourcing components from repair marketplaces. By tracking the environmental impact of each repair, these systems can quantify reductions in e-waste and CO<sub>2</sub> emissions. Partnering with platforms like iFixit and Back Market could further expand access to affordable repairs, empowering users with sustainable maintenance solutions while supporting a circular economy.

### Classroom Activity:

Ask LLMs to identify faulty components from photos and discuss if they are good assistants for this task.

Develop a rule-based chatbot using tools like DialogFlow or <https://botpress.com/es> to diagnose common laptop/phone issues. Simulate a repair scenario where AI suggests replacement parts from a recycled inventory.

The chatbot can be very simple at start, but as you continue explaining concepts about repairing PCs, students can improve the bot until the end of the course. It will become an expert at the same time as the students.

### Activity 1: Identifying Digital Tools that Support Sustainability

Time: 3-4 hours

Objective: Help students recognise how digital tools can actively contribute to sustainability goals in education and professional contexts.

Description: The teacher introduces the concept of digital tools for sustainability, explaining that technology can either increase environmental impact or help reduce it.

Students brainstorm examples of digital tools they already know or use (apps, platforms, software).

Each group maps existing practices into categories:

- Energy efficiency (e.g. monitoring, optimisation)
- Resource management (data, materials, logistics)
- Environmental monitoring
- Communication and dematerialisation (reducing travel, paper)

Each group selects two tools and explains:

- What problem they address
- How they reduce environmental impact

Groups present their conclusions to the class.

Outcome: Students understand that digital tools are not neutral and can be powerful enablers of sustainable practices.

### Activity 2: Digital Tools vs Environmental Impact: Case Studies

Time: 4-5 hours

Objective: Develop critical thinking by analysing real or realistic cases where digital tools are used to improve sustainability.

Description: The teacher provides short case studies (or scenarios) related to different sectors, such as:

- Smart energy management in buildings
- Digital platforms for waste reduction
- Precision agriculture tools
- Remote work and online collaboration

In small groups, students analyse one case study, answering:

- What digital tool is used?
- What environmental problem does it address?
- What are the benefits?
- Are there any possible negative impacts?

Groups prepare a short presentation or poster summarising their analysis.

Outcome: Students learn to evaluate both the advantages and limitations of digital tools from a sustainability perspective.

### Activity 3: Artificial Intelligence as a Tool for Sustainability

Duration: 3-4 hours

Objective: Introduce students to the dual role of Artificial Intelligence (AI) as both a sustainability challenge and a solution.

Description: The teacher explains, in simple terms, how AI can:

- Optimise energy use
- Improve logistics and transport efficiency
- Support predictive maintenance
- Reduce waste

Students are divided into groups and assigned one application of AI (energy, mobility, industry, agriculture, education).

Each group identifies:

- How AI helps reduce environmental impact
- What data is needed
- What risks or challenges exist (energy consumption, ethics, access)

Groups present their findings, followed by a class discussion on responsible use of AI.

Outcome: Students gain a balanced understanding of AI, avoiding both blind enthusiasm and rejection.



## MODULE 4

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# CIRCULAR ECONOMY AND SUSTAINABLE DIGITAL PRACTICES

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TRAINING STUDENTS AND PROFESSIONALS IN VOCATIONAL EDUCATION AND TRAINING (VET) TO UNDERSTAND AND APPLY THE PRINCIPLES OF THE CIRCULAR ECONOMY IN THE DIGITAL CONTEXT IS AN ESSENTIAL ACTION IN THE FACE OF CONTEMPORARY CHALLENGES. BY INTEGRATING SUSTAINABLE PRACTICES WITH THE OPPORTUNITIES OFFERED BY TECHNOLOGICAL TRANSFORMATION, THIS APPROACH CONTRIBUTES DIRECTLY TO THE DUAL TRANSITION - ECOLOGICAL AND DIGITAL - BY PROMOTING EDUCATION IN LINE WITH THE DEMANDS OF A MORE RESILIENT, INCLUSIVE AND ENVIRONMENTALLY RESPONSIBLE FUTURE.

THIS MODULE COMPLEMENTS THE OVERVIEW PRESENTED IN MODULE 1, THE INSTITUTIONAL AND CAMPUS SUSTAINABILITY PRACTICES COVERED IN MODULE 2, AND THE AI AND DATA TOOLS EXPLORED IN MODULE 3. THE FOCUS HERE IS ON TRANSLATING THESE PRINCIPLES INTO CONCRETE DECISIONS ABOUT THE PURCHASE, USE, MAINTENANCE, REPAIR, AND DISPOSAL OF DEVICES, AS WELL AS THE DAILY USE OF SOFTWARE, CLOUD SERVICES, AND DATA.

### What is the Circular Economy?

The circular economy is a production and consumption model that prioritises the reduction, reuse, recovery and recycling of materials and energy. Instead of following the traditional linear model (extract → produce → discard), the circular economy aims to keep resources in use for as long as possible.

The key principles of this model are fundamental to its implementation. Sustainable design is at the heart of the circular economy, promoting products that not only last longer, but are also designed to be easily recyclable or reusable. Recovery and reuse ensure that components and materials are continually reintegrated into the production system, while waste minimisation drastically reduces environmental impact, especially electronic waste. These principles show that the circular economy is not just an idealistic concept, but a practical necessity for tackling today's environmental challenges.

### The Circular Economy in the Digital Context

In the digital world, where advanced technologies are increasingly present in our lives, the circular economy is playing a crucial role. The increased use of electronic devices, from smartphones to data servers, has generated significant environmental impacts. To mitigate these effects, it is essential to apply the principles of the circular economy to digital technology, promoting more conscious and sustainable practices.

However, there are important challenges to overcome. Planned obsolescence, for example, encourages the premature disposal of still-functional devices. The accumulation of electronic waste (e-waste) is another major problem, with millions of tonnes being discarded every year without proper treatment. In addition, excessive energy consumption in data centres and devices contributes to carbon emissions. The circular economy offers solutions to minimise these impacts, from designing more durable products to adopting more efficient energy infrastructures.

## Sustainable Digital Practices

In the digital world, the circular economy is not just limited to hardware, but can also be applied in innovative ways to software and data. As the use of digital technologies grows exponentially, so does the environmental impact associated with creating, storing and processing software and data. The circular economy, in this context, seeks to optimise the use of digital resources, reduce waste and promote more conscious and sustainable practices.

Hardware-related challenges:

**Reduce** - The first step towards more sustainable technology is to avoid unnecessary consumption. Before buying a new device, assess whether it is really essential. Opt for products with energy efficiency certification, such as the Energy Star or EPEAT seals. In addition, the conscious use of cloud storage can reduce the need for additional servers, reducing the environmental impact.

**Reuse** - Many old devices can still be put to good use. An old smartphone can become a security camera, an outdated tablet can be used as an e-book reader, and a slow laptop can be turned into a home server. Donations to schools, NGOs or social projects are also a great way to extend the life of technology.

**Recycling** - When a device reaches the end of its useful life, proper disposal is essential. Many electronic components contain precious metals and hazardous materials, which must be processed at specialised sites. Look for e-waste collection points or manufacturers' recycling programmes.



**Maintain and Repair** - The culture of repair is at the heart of the circular economy. Instead of replacing equipment at the first sign of a problem, try repairing it. Platforms such as iFixit offer free tutorials for repairs, from changing batteries to repairing motherboards. Basic maintenance, such as fan cleaning and software updates, can also significantly extend the life of devices.

Challenges related to software and data:

**Software obsolescence:** A lot of software is discontinued or replaced by newer versions, even when the basic functionalities still meet users' needs. This generates a constant cycle of unnecessary updates, consuming energy and computing resources.

**Excessive data storage:** Large volumes of data are stored uncritically, taking up space on servers that consume energy to operate and cool. Much of this data is duplicated, outdated or simply never accessed again.

**Energy inefficiency of systems:** Poorly optimised software can require more processing power

than necessary, increasing energy consumption in devices and data centres.

Opportunities for the circular economy in software and data:

The circular economy in the digital context encourages a more efficient and responsible approach to software development and use, as well as data management. This includes:

**Modular and scalable software design:** Developing software that can be updated and adapted over time, without the need for complete replacement. This extends its useful life and reduces the waste of resources.

**Compacting and cleansing data:** Implement regular data organisation and cleansing practices, eliminating redundant or obsolete information. This reduces the demand for storage and optimises the use of servers.

**Efficient use of computing resources:** Prioritise lightweight, well-optimised software that minimises energy consumption during execution. In addition, encourage the use of cloud computing



infrastructures with energy efficiency certification.

**Culture of sharing and reuse:** Promote collaborative platforms where codes, libraries and software tools can be shared and reused, avoiding duplication of effort and resources.

By applying the principles of the circular economy to software and data, it is possible to significantly reduce the environmental impact of the digital sector, promoting a more sustainable and resilient technological ecosystem.

### Good Practices in Vocational Education and Training

Education and professional training play crucial roles in disseminating the principles of the circular economy in the digital context, especially when focussed on software and data. Preparing students and professionals to deal with these resources in a conscious and sustainable way is essential to building a more efficient and responsible digital future.

#### At the school/training workshop:

Encourage prolonged use of institutional equipment, avoiding unnecessary replacement. Promote repair and reuse workshops, teaching students practical skills that can be applied in their personal and professional lives. In addition, integrate digital sustainability projects into curricula, connecting theory and practice.

**Promote prolonged use of software:** Encourage the use of stable versions of software for longer periods, avoiding unnecessary updates that consume energy and computing resources. Teach students to assess whether a new version really brings significant benefits before adopting it.

**Create workshops on efficient data management:** Organise practical activities where students learn how to organise, compact and clean data on a regular basis. This includes identifying duplicate files, eliminating obsolete information and consciously prioritising cloud storage.

**Introduce software optimisation projects:** Insert challenges into the curriculum that encourage students to develop or adapt lightweight, efficient

and scalable software, reducing the environmental impact associated with data processing.

**Professional training:** Prepare students to operate in the green and circular market by empowering them with digital skills aligned with environmental responsibility. Encourage innovation in areas such as energy efficiency, sustainable product design and electronic waste management. These skills will be increasingly valued in a world seeking more sustainable alternatives.

**Training for the sustainable digital market:** Prepare students to work in a market that values sustainable practices in the development and use of software. This includes skills such as modular software design, efficient programming and responsible data management.

**Encourage innovation in digital sustainability:** Promote competitions or hackathons where participants can create innovative solutions to problems such as excessive data storage, energy consumption of systems and sharing of digital resources.

**Fostering an open source and collaborative culture:** Teach students how to contribute to open source platforms by reusing and improving existing tools. This reduces duplication of effort and encourages a mentality of reuse and collaboration.

**Connecting digital competences and environmental responsibility:** By integrating the principles of the circular economy into software and data teaching, educational institutions can help train professionals who not only master digital technologies, but also understand their environmental impact. These skills are increasingly valued in the labour market, especially in sectors looking to transition to more sustainable models.

#### Practical example:

A school or training centre could implement a project where students develop a data management system for a local organisation. The aim would be to create a solution that minimises unnecessary storage, reduces energy consumption and facilitates the secure sharing of information. This type of initiative connects theory and practice, promoting a deeper understanding of circular economy principles applied to software and data.



## Inspiration: European examples

Europe has been a pioneer in implementing initiatives that promote the circular economy in the digital context.

**NL Restart Party (Holanda):** Community events where experts help people repair their devices, promoting a culture of repair and reducing premature disposal.

**DE iFixit Europe:** A collaborative platform that offers detailed repair tutorials, empowering users to take control of their devices and extend their lifespan.

**PT Escolas Sustentáveis (Portugal):** Initiatives that integrate the maintenance of digital equipment as part of the school curriculum, teaching students the importance of sustainability from an early age.

These examples demonstrate that small collective actions can have a significant impact on promoting a more inclusive and effective circular economy.

## Suggested Activity: Sustainable Digital Diagnosis

Para colocar os princípios da economia circular em prática, proponha um diagnóstico digital sustentável na sua escola.

### Activity 1:

To put the principles of the circular economy into practice and continue with the 'Digital Clean-up Day' presented in Module 2, propose a sustainable digital diagnosis at your school.

1. Carry out a detailed survey of used devices, including information on their state of repair, age and energy efficiency.
2. Evaluate which equipment can be reused, repaired or replaced with more sustainable options.
3. Propose concrete actions based on circular economy principles, such as setting up a community repair station or partnering with local recycling initiatives.

The results of this diagnosis can feed into or update the School Sustainability Audit presented in Module 2, ensuring that the digital aspect (equipment, infrastructure, online services) is fully integrated into the institution's overall sustainability strategy.

### Activity 2:

#### Step 1: Evaluation of Software Use

**Mapping the software used:** Carry out a detailed survey of the software installed on institutional devices. Identify which is really necessary and which is under-utilised or duplicated.

**Energy efficiency analysis:** Check that the software in use is optimised for energy consumption. Poorly designed or outdated software can require more processing power, increasing the environmental impact.

**Obsolescence assessment:** Determine whether current software still meets the organisation's needs or whether there are lighter, more scalable alternatives available.

#### Step 2: Data Management

**Data storage audit:** Review data stored on servers, clouds or local devices. Identify duplicate, outdated or unnecessary files that can be deleted.

**Data classification:** Categorise data based on its relevance and frequency of use. Prioritise the retention of essential information and assess the possibility of migrating infrequently accessed data to energy-efficient systems.

**Compacting and cleansing:** Implement regular routines for compacting files and deleting obsolete data to reduce the demand for storage space.

#### Step 3: Proposed Actions Based on the Circular Economy

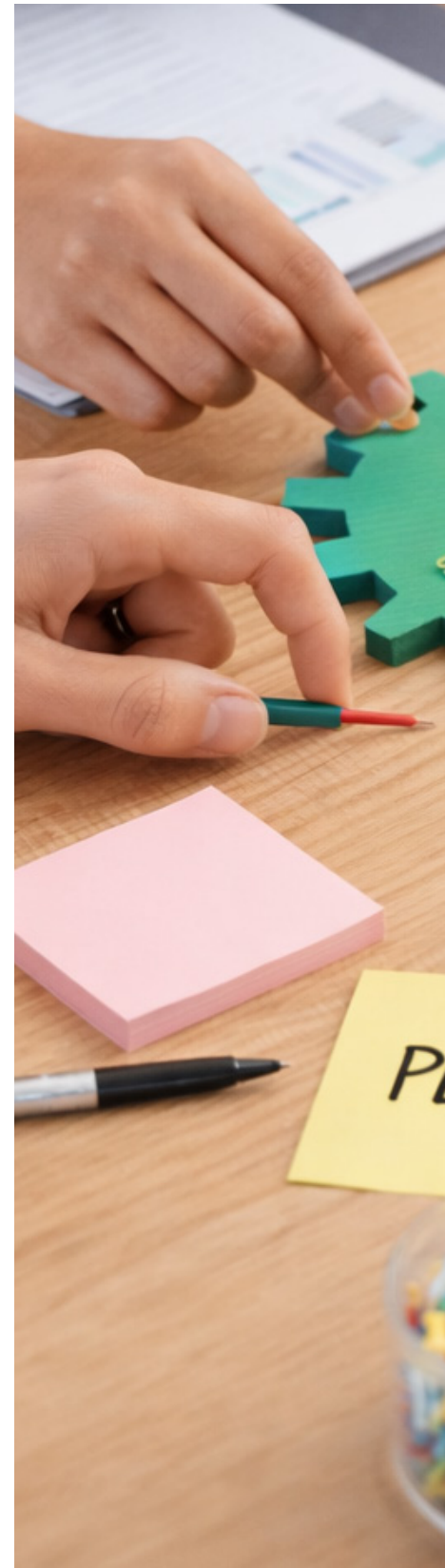
Based on the findings of the diagnosis, propose concrete actions to promote a more sustainable approach to software and data:

**Adoption of modular and scalable software:** Replace outdated or inefficient software with solutions that can be upgraded without the need for complete new installations.

**Implementing data management policies:** Create clear guidelines for organising, cleansing and sharing data responsibly, minimising the waste of digital resources.

**Efficient use of collaborative platforms:** Encourage the use of open source tools and digital resource sharing platforms to avoid duplication of effort and maximise the reuse of software and data.

**Training and awareness:** Organise workshops or training sessions to educate users about sustainable



practices in the use of software and data, such as the importance of cleaning files regularly and choosing efficient tools.

Practical example:

Imagine that, after carrying out the diagnosis, you discover that your school is storing thousands of duplicate files and that a lot of software installed on the computers is not used regularly. Based on these findings, you could propose

The creation of an institutional policy to review and cleanse data every six months.

Replacing heavy, little-used software with lighter, free alternatives, such as open source tools.

Organising an internal campaign to make students and teachers aware of the importance of managing data and software responsibly.

### Activity 3:

#### Step 1: Evaluating the Use of Personal Software

Take stock of the apps and programmes you use: List all the software installed on your mobile phone, tablet or computer. Include social networking apps, games, study tools and others.

Which ones are really useful in your day-to-day life?

Are there applications you haven't used in months?

Are there lighter or free alternatives to programmes that consume a lot of energy or space?

Analyse the energy impact: Research (or estimate) the energy consumption of the applications you use most. For example, heavy applications such as games or video editors can require more processing power, increasing battery and energy consumption. Can you replace some of these apps with lighter versions or use online tools that don't need to be installed?

Uninstall the unnecessary: Based on your analysis, uninstall apps that you no longer use or that have more efficient alternatives.

#### Step 2: Personal Data Management

Review your photos, videos and files: Open your mobile phone or cloud and assess what's stored there.

How many duplicate photos or videos do you have?

Are there old files you can't access, such as old schoolwork or unnecessary downloads?

Is there anything that can be deleted or transferred to external storage (such as a hard drive or USB stick)?

Organise your data: Create folders or categories to organise your files. For example:

Important photos → "Memories"

Schoolwork → "School"

Temporary downloads "To Delete"

Regular cleaning: Set yourself a monthly routine to review and clean your files, eliminating what you no longer need.

#### Step 3: Reflect on Digital Habits

Amount of data in the cloud: Reflect on how much space you take up in cloud storage services such as Google Drive or iCloud.

Do you really need everything there?

Are there files that can be downloaded and stored locally to free up space in the cloud?

Use of social networks and streaming: Think about how you consume content online.

Do you download videos or music that you never watch/listen to again?

Could you reduce the time you spend on social networks or streaming platforms to cut down on data and energy consumption?

#### Step 4: Propose Sustainable Actions

Based on the findings of the diagnosis, create a personal plan to make your digital use more sustainable:

Adopt more efficient software and apps: Replace heavy applications with lighter alternatives. For example, use browsers that consume less energy or organisational apps that don't take up as much space.

Practice regular digital cleaning: Take a moment each month to review and organise your files, eliminating what you no longer need.

Reduce cloud storage: Download important files to your device and delete copies in the cloud to save energy on servers.

Share consciously: Before sending large files by email or messaging, compress them or use sharing links to avoid sending duplicate data.

Practical example:

Imagine that, when you carry out the diagnosis, you discover that you have more than 500 duplicate photos on your mobile phone and that you only use 5 of the 20 applications installed. Based on this, you can:

Create an album called "Favourites" with the most important photos and delete the duplicates.

Uninstall the apps you no longer use and replace some of them with lighter or free versions.

Set a personal goal of reviewing your files every 30 days to keep everything organised and sustainable.

This activity helps young people understand how their digital habits impact on the environment and encourages them to adopt more responsible practices when using software and data. By applying these changes in their daily lives, they will be contributing to a more sustainable and efficient digital world.

If your class has already participated in "Digital Cleanup Day" (Module 2), this activity serves as a natural follow-up: the goal is for each student to turn this experience into an ongoing personal plan, taking responsibility for their digital habits over time and regularly reviewing their data, app, and storage consumption.

Teachers working on AI and data projects described in Module 3 can use this personal plan as an ethical and environmental reference to discuss with students the impact of their digital habits when they use AI models, store large volumes of data, or make intensive use of online services.

**Activity 1:** Workshop: “From the Drawer to the Classroom”

Time: 1-2 hours

Objective:

- Understand the life cycle of electronic equipment.
- Encourage a culture of reuse and repair.
- Develop critical thinking about sustainable disposal.

Resources needed:

- Examples of old devices (cell phones, tablets, chargers, etc.).
- Whiteboard/cardboard or digital mural (Padlet, Jamboard, Canva).
- Drawing and collage materials (if in physical format).

- Steps:
1. Introduce concepts of circular economy and electronic waste.
  2. Organize groups of students to analyze the devices (or research examples).
  3. Identify:
    - State of conservation. | Ways to reuse. | Proper disposal alternatives..
  4. Create a “map of circular solutions” on a poster or digital mural.
  5. Present the solutions in plenary session.

Evaluation criteria:

Active participation in discussions. | Clarity and creativity in the solutions presented. | Ability to relate the concept of circular economy to real-life examples

**Activity 2:** “Sustainable Data Management” Challenge

Time: 1-2 hours

Objective:

- Reflect on the environmental impacts of digital storage.
- Develop data organization habits.
- Encourage conscious choices in the use of software and applications.

Resources needed:

- Students’ personal devices (computers/cell phones).
- Internet access (optional, for researching alternative apps).
- Report/infographic template (in Canva, Google Docs, or physical poster).

- Steps:
1. Explain how digital data and software impact energy consumption.
  2. Ask students to conduct a digital audit (apps, photos, videos, files).
  3. Guide them in identifying duplicates, obsolete data, and heavy apps.
  4. Create a personal digital cleanup plan.
  5. Each student presents the before and after results (how many GB freed up, apps replaced, etc.).

Evaluation criteria:

Quality of individual diagnosis. | Organization and clarity of the report/infographic. | Critical reflection on how small changes reduce environmental impact.

**Activity 3:** Collaborative Project “Digital Circular School”

Time: 3-4 hours

Objective:

- Apply the principles of the circular economy in a school context.
- Develop collaborative work skills.
- Create real digital sustainability solutions in the educational community.

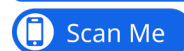
Resources needed:

- Access to school equipment (computers, tablets, servers).
- Spreadsheets for data collection.
- Collaborative digital tools (Docs, Sheets, Trello, Miro, etc.).

- Steps:
1. Divide the class into 3 teams:
    - o Hardware – Lift reusable or repairable equipment.
    - o Software – Evaluate programs used and seek lighter alternatives.
    - o Dados – Create proposals for organization, backup, and digital cleanup.
  2. Each team prepares a diagnosis and proposals for action.
  3. Combine the proposals into a collective plan for the school.
  4. Present in poster, presentation, or video format

Evaluation criteria:

Teamwork and collaboration. | Relevance and applicability of proposals. | Creativity in the final presentation. | Ability to connect theory (circular economy) with the reality of the school.







## MODULE 5

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# ENVIRONMENTAL IMPACT OF DIGITAL TECHNOLOGIES

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DIGITALISATION HAS BECOME ONE OF THE DEFINING FORCES OF THE 21ST CENTURY. IT SHAPES THE WAY SOCIETIES PRODUCE, COMMUNICATE, AND CONSUME, WHILE INFLUENCING EDUCATION, EMPLOYMENT, AND CULTURAL EXCHANGE. YET, DESPITE THE PERCEPTION OF DIGITAL TECHNOLOGIES AS INTANGIBLE, THEY ARE GROUNDED IN PHYSICAL INFRASTRUCTURES THAT CONSUME VAST AMOUNTS OF ENERGY, WATER, AND RAW MATERIALS. EVERY ONLINE ACTIVITY—FROM STREAMING A FILM TO SHARING A DOCUMENT IN THE CLOUD—RELIES ON A CHAIN OF SERVERS, NETWORKS, AND DEVICES THAT LEAVE A MEASURABLE MARK ON THE PLANET.

UNDERSTANDING THE HIDDEN COSTS OF DIGITALISATION IS CRUCIAL, ESPECIALLY AT A TIME WHEN THE EUROPEAN UNION HAS COMMITTED TO THE TWIN TRANSITION: ADVANCING BOTH THE GREEN AND DIGITAL AGENDAS IN PARALLEL. WHILE DIGITAL TOOLS OFFER OPPORTUNITIES TO IMPROVE ENERGY EFFICIENCY, PROMOTE CIRCULAR ECONOMY PRACTICES, AND CONNECT COMMUNITIES, THEY ALSO GENERATE ENVIRONMENTAL PRESSURES AND SOCIAL RISKS IF LEFT UNMANAGED. THIS DUALITY MAKES THE DEBATE ON THE DIGITAL IMPACT OF NEW TECHNOLOGIES PARTICULARLY RELEVANT FOR EDUCATORS, POLICYMAKERS, AND PROFESSIONALS.

IN THE CONTEXT OF VOCATIONAL EDUCATION AND TRAINING (VET), THE TOPIC BECOMES EVEN MORE STRATEGIC. STUDENTS AND FUTURE WORKERS NEED TO UNDERSTAND HOW THE DIGITAL SECTOR INTERSECTS WITH SUSTAINABILITY GOALS, NOT ONLY BECAUSE THEIR FUTURE JOBS WILL DEPEND ON THESE SKILLS, BUT ALSO BECAUSE THE CHOICES MADE TODAY WILL DEFINE WHETHER DIGITAL TRANSFORMATION SUPPORTS OR UNDERMINES THE OBJECTIVES OF THE EUROPEAN GREEN DEAL. THIS CHAPTER EXPLORES THE KEY DIMENSIONS OF DIGITAL IMPACT: THE NOTION OF THE DIGITAL FOOTPRINT, THE SYSTEMIC LAYERS OF DIGITAL INFRASTRUCTURES, THE ENVIRONMENTAL COSTS OF DATA CENTRES AND ARTIFICIAL INTELLIGENCE, THE RISE OF ELECTRONIC WASTE, AND THE ETHICAL AND SOCIAL RISKS LINKED TO DIGITALISATION. IT CONCLUDES WITH A SET OF STRATEGIES AND A DISCUSSION ON HOW VET CAN ACT AS A BRIDGE BETWEEN INNOVATION AND SUSTAINABILITY

### Digital Footprint, Data Footprint and Digital Waste

The concept of the digital footprint highlights the fact that digitalisation is not immaterial. Behind every online action—sending an email, joining a video conference, or watching a film—there are servers, networks, and devices that consume electricity, water, and raw materials. The digital footprint is commonly divided into three dimensions. The carbon footprint refers to the greenhouse gas emissions linked to electricity consumption and production chains. The water footprint is associated with the enormous volumes of water needed for cooling

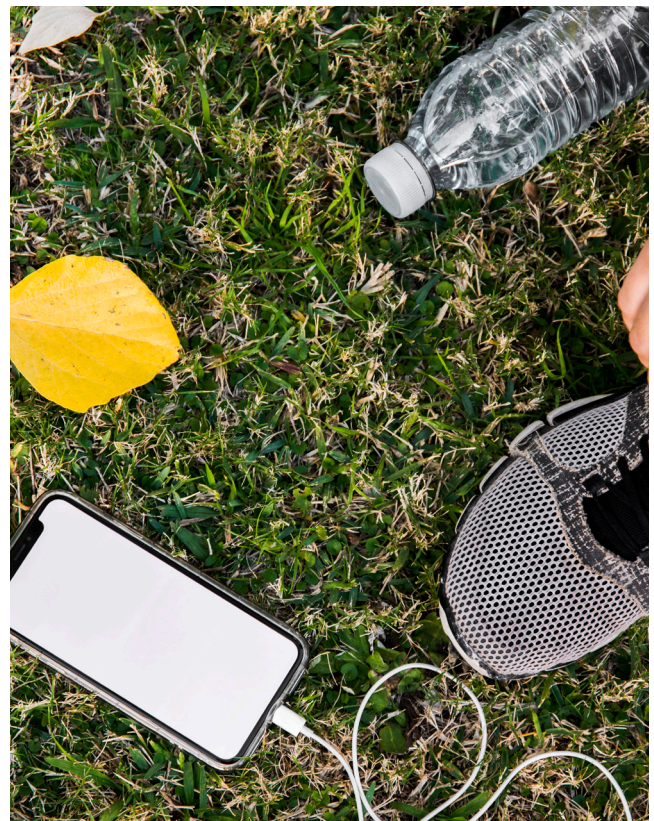
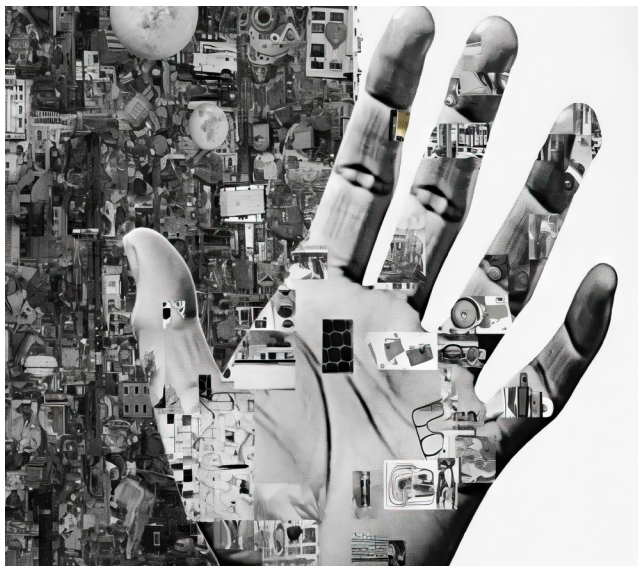
systems in data centres and for manufacturing devices. Finally, the material footprint comes from the extraction and use of critical raw materials such as lithium, cobalt, and rare earth elements, which are essential for batteries and electronic components. These dimensions make clear that the digital world has very concrete, physical consequences.

The carbon impact of the ICT sector is now estimated to account for a share of global emissions similar to, or in some cases higher than, that of aviation. Streaming platforms, cloud services, and online gaming are among the most energy-intensive activities because they require constant flows of data and permanent storage. Even though efficiency gains have been made through better hardware and optimised software, demand has grown so rapidly that overall emissions continue to rise. This is known as the rebound effect: improvements in efficiency are outweighed by the exponential growth of digital consumption.

The water dimension is often less visible but equally significant. Large data centres use millions of litres of fresh water every day to cool their servers. In regions already affected by drought, this creates a direct competition between the digital economy and local communities or agriculture. In addition, water is also consumed during the production process of devices: from mining operations to chip manufacturing, each stage leaves a water footprint that is rarely accounted for in consumer choices.

Another crucial element is the material footprint. Modern digital devices depend on dozens of minerals and metals that are mined and transported across the globe. The extraction of these materials frequently causes deforestation, soil and water contamination, and social conflict in the communities where mines are located. The dependence on nonrenewable raw materials exposes the fragility of a linear digital economy based on short product lifespans and constant replacement of equipment. This dependency also raises strategic concerns, as supply chains for critical raw materials are highly concentrated in a few countries, creating vulnerabilities for Europe and beyond.

In addition to these physical dimensions, the **data footprint** has emerged as a pressing challenge. It refers to the sheer volume of information that societies produce,



store, and replicate. While data may appear to be weightless, the infrastructures that maintain them—servers, cables, security systems—demand significant energy and water. The tendency to store everything indefinitely, often in multiple copies, multiplies the demand for capacity. Forecasts from European institutions show that data volumes are expected to grow several times over within this decade, leading to a corresponding increase in resource use.

Linked to this is the problem of **digital waste**, sometimes described as the “dark matter” of the digital world. This includes emails that are never opened, duplicate files, outdated applications, unused backups, and videos stored indefinitely on servers. Although invisible to most users, these data consume energy and require permanent infrastructures

to remain accessible. Research suggests that only a small fraction of stored data are actively used, while the vast majority fall into this category of digital waste. Beyond the environmental impact, digital waste also raises cybersecurity concerns, as forgotten data or outdated systems can become vulnerable to breaches.

The combined perspective of digital footprint, data footprint, and digital waste demonstrates that digitalisation is deeply material, with consequences for energy, water, ecosystems, and societies. Recognising these impacts is a first step towards integrating sustainability into digital policies and practices. For Europe, this is directly connected with the goals of the Green Deal and the twin transition, which call for aligning the digital transformation with environmental and social responsibility.



## SYSTEMIC LAYERS OF DIGITAL IMPACT

The environmental and social consequences of digitalisation can be better understood when examined across several systemic layers. Each layer—from devices to cultural practices—represents a different stage in the chain of infrastructures that make digital life possible. Analysing these layers shows how digital systems depend on global networks of energy, materials, and human behaviour, and why sustainability strategies must address the sector as a whole rather than focusing on isolated components. The first layer consists of **devices and their production processes**. Every smartphone, laptop, and server begins its journey with the extraction of raw materials such as lithium, cobalt, copper, and rare earths. Mining operations are energy-intensive, often located in fragile ecosystems, and associated with environmental degradation

and social conflict. Once extracted, these resources pass through global supply chains that involve refining, transport, and assembly. Manufacturing consumes large amounts of energy and water, and produces emissions long before a device reaches the hands of the consumer. On top of this, rapid cycles of innovation and marketing create planned and perceived obsolescence: devices are replaced after only a few years, leading to continuous pressure on ecosystems and a steady rise in electronic waste. The second layer is the **transmission networks** that enable the flow of data across the globe. This layer includes terrestrial and undersea fibreoptic cables, mobile infrastructures such as 4G and 5G antennas, and satellite systems. Maintaining these networks requires

Teachers and schools are the driving force behind the Twin Transition, transforming education through sustainable digital practices, updated curricula, and learning applied to the real challenges of the green and digital economy.

electricity 24 hours a day, as the demand for constant connectivity allows no pause. The rollout of 5G and the expansion of the Internet of Things have multiplied the number of connected devices and exponentially increased data traffic. Although newer networks are more energy-efficient per unit of data, overall consumption continues to rise due to the sheer scale of demand, a phenomenon known as the rebound effect. This demonstrates that efficiency gains alone cannot guarantee sustainability unless accompanied by systemic reductions in consumption.

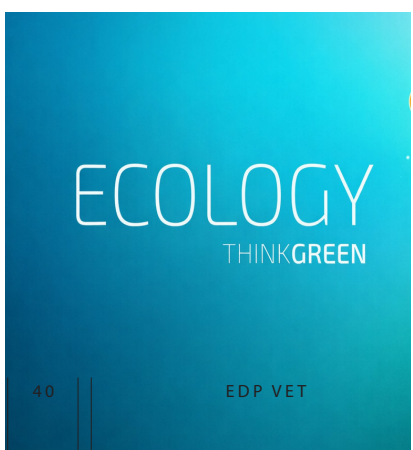
The third layer is **data centres**, which serve as the backbone of digital infrastructures. They host cloud storage, run enterprise applications, and process artificial intelligence models. Operating continuously, data centres account for between 1% and 1.5% of global electricity consumption, with additional impacts from water use in cooling systems. Their carbon intensity varies according to the energy mix of the region in which they are located: facilities in countries that rely heavily on coal or natural gas have far higher emissions than those powered largely by renewables. While companies are investing in energy efficiency and renewable energy, the rapid growth of digital demand risks outpacing these improvements.

The fourth layer concerns **software and the logical architecture** of digital services. Software efficiency plays a critical role in determining how much energy is required to perform digital tasks. When applications are poorly optimised, they demand more processing power and

memory, forcing users to purchase new hardware sooner than necessary. This phenomenon, often described as “software bloat,” drives obsolescence and resource consumption. Conversely, lean and efficient coding can extend the lifespan of devices and reduce the energy required for daily operations. At the same time, the exponential growth of stored data — much of it unused — further increases the demand for infrastructures and perpetuates the problem of digital waste.

Finally, the fifth layer is **human practices and cultural behaviour**. Digital infrastructures only exist because societies demand constant access to communication, entertainment, and services. Everyday habits—such as watching videos in ultrahigh definition, keeping devices permanently connected, or using cloud storage as the default option—create significant environmental impacts that are rarely visible to users. Social expectations of immediacy and convenience reinforce these behaviours. From this perspective, the sustainability of digitalisation is not only a technical issue but also a cultural one. Addressing it requires awareness, behavioural change, and the integration of sustainability principles into education and professional training.

Taken together, these systemic layers show that the digital world is embedded in material, energy, and social systems. Any serious approach to digital sustainability must look beyond single elements such as device recycling or network efficiency, and instead tackle the interdependencies that bind production, infrastructures, software, and cultural use. This systemic perspective is what allows policymakers, businesses, and educators to identify where interventions can have the most transformative effects.



## DATA CENTRES: ENERGY, WATER AND EMISSIONS

Data centres are the backbone of the digital economy. They host the cloud services that individuals and businesses use daily, provide storage for the exponential growth of data, and supply the computing power needed for artificial intelligence, big data analysis, and highfrequency transactions. However, behind this invisible service lies an infrastructure that consumes extraordinary amounts of energy and water and generates substantial carbon emissions.

The **energy dimension** is the most widely recognised. Globally, data centres are estimated to consume between 220 and 320 terawatthours (TWh) of electricity



each year, equivalent to about 1–1.5% of total global demand. This figure is comparable to the electricity consumption of a medium-sized industrialised country. The energy is required not only to power millions of servers but also to maintain optimal operating conditions, including cooling, lighting, and security. Some of the largest hyperscale facilities use as much electricity as a city of several hundred thousand inhabitants. While advances in efficiency, such as the adoption of renewable power purchase agreements and improved hardware, have helped stabilise growth in consumption, the overall trajectory



remains upward due to increased demand for streaming, cloud services, and AI applications.

The **water dimension** has received less attention but is equally significant. Cooling is a critical function in data centres, as servers generate substantial heat during operation. Many facilities rely on evaporative cooling, which consumes millions of litres of fresh water every day. This creates growing tensions in regions already facing water scarcity, where data centres compete with agriculture and communities for limited resources. New approaches such as liquid immersion cooling, the use of recycled water, and location in colder climates are being explored, but the scale of global demand means

the problem remains acute. For example, data centre clusters in arid regions such as the western United States or parts of southern Europe are raising questions about the longterm sustainability of siting decisions.

Carbon emissions represent the third critical issue. The climate impact of a data centre depends heavily on the local energy mix. Facilities operating in regions dominated by fossil fuels, such as coal or gas, have a far larger carbon footprint than those powered by renewables. Even where renewable integration is high, the roundtheclock demand for stable electricity supply means that fossil fuels often remain part of the mix. Companies such as Google, Microsoft, and Amazon have committed to

achieving carbonneutral or even carbonnegative operations, yet their rapid expansion raises concerns about whether efficiency gains and renewable sourcing will keep pace with the scale of growth. The European Union has set a target that all European data centres must be climateneutral by 2030, making this a central benchmark for the industry.

Beyond the direct impacts of energy, water, and emissions, there are also broader systemic effects. The clustering of data centres in specific regions creates localised pressures on energy grids and water supplies. These infrastructures also have economic and geopolitical implications: countries that can provide cheap, stable, and renewable energy are becoming magnets for investment, while others risk exclusion from this strategic sector. Moreover, the waste heat generated by data centres presents both a challenge and an opportunity. In some European cities, this heat is being captured and used to provide district heating, showing how innovative solutions can partially mitigate environmental costs.

In short, data centres epitomise the paradox of digitalisation: they are essential for enabling innovation and services that societies increasingly rely upon, yet their environmental costs are substantial and growing. Addressing this challenge requires a combination of technological innovation, regulatory standards, and societal awareness. For educators and students in VET, understanding the functioning and impacts of data centres is key to preparing for a labour market in which sustainable digital practices will become both a necessity and a competitive advantage.

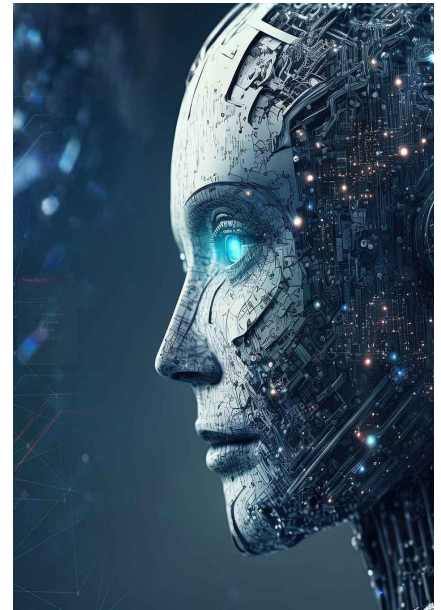


## ARTIFICIAL INTELLIGENCE AND NEW ENERGY DEMANDS

Artificial intelligence (AI) is one of the most transformative technologies of our time, reshaping how we interact with information, automate processes, and make decisions. Its environmental impact is increasingly a cause for concern. The rapid expansion of AI, particularly large scale machine learning models, demands vast computing resources, generating unprecedented energy and water consumption. While AI has the potential to contribute to sustainability through optimised

energy systems, smart mobility, or precision agriculture, its own ecological footprint reveals a doubleedged reality.

The **energy demands of AI training** are especially striking. Training a large language model or advanced neural network requires thousands of highperformance graphics processing units (GPUs) or tensor processing units (TPUs) running continuously for weeks or even months. Each training cycle involves billions of parameters and calculations, consuming electricity on a scale comparable to the lifetime



emissions of multiple cars. While companies are investing in specialised chips designed for efficiency, the sheer growth in demand for AI models used in healthcare, finance, education, and creative industries means that total energy consumption is expected to continue rising. The paradox is evident: as models become more powerful, their training requires exponentially more energy, even if peroperation efficiency improves.

AI also has a substantial **water footprint**, largely hidden from public view. Data centres hosting AI training and inference operations rely on cooling systems that consume enormous amounts of water. Recent research has shown that training a single state of the art language model can use hundreds of thousands of litres of freshwater for cooling purposes. Furthermore, AI is not just energy intensive at the training stage: once deployed, inference the process of applying the trained model to real world tasks occurs billions of times every day across cloud platforms and consumer devices. This means that the water and energy impacts of AI are continuous, not occasional.

Beyond energy and water, AI raises broader **systemic sustainability dilemmas**. The rebound effect is particularly visible here: the more efficient and accessible AI becomes, the more widely it is applied. Instead of reducing demand, efficiency often fuels expansion into new sectors and services. This pattern risks locking societies into evergrowing resource use. Ethical considerations compound this issue. Allocating massive amounts of electricity and water to train chatbots, recommendation systems, or automated image generators raises questions about priorities, especially in a world where access to energy and clean water remains unequal.



At the same time, AI offers opportunities for sustainability. Applied responsibly, machine learning can help optimise electricity grids, reduce food waste through predictive logistics, and design energy efficient buildings. AI can also accelerate climate modelling, improving predictions and resilience planning. The challenge is therefore not simply to limit AI development, but to ensure that it is aligned with environmental goals and regulated to prevent disproportionate impacts. Initiatives like the European Union's AI Act seek to balance innovation with safety, transparency, and sustainability.

For vocational education and training (VET), understanding AI's environmental footprint is essential. Tomorrow's professionals will not only use AI tools but also manage their deployment in workplaces. Teaching them to critically evaluate the energy, water, and material implications of AI equips them to make informed decisions that balance efficiency with responsibility. This knowledge is vital if Europe is to pursue a digital transformation that supports rather than undermines the European Green Deal.

## ELECTRONIC WASTE

Electronic waste, or e-waste, has become the fastest growing waste stream in the world. Every year, millions of tonnes of discarded computers, mobile phones, televisions, and other electronic devices are generated, and only a small proportion is properly collected and recycled. The rest often ends up in landfills, incinerated, or shipped to countries with weaker environmental regulations. This creates not only environmental challenges but also social and economic inequalities. The European Green Deal identifies e-waste management as a critical issue for achieving a circular economy, underlining the need to extend the life of devices and recover valuable materials.

The **environmental consequences** of e-waste are severe. Devices contain hazardous substances such as lead, mercury, and brominated flame retardants that can contaminate soil and water. Informal recycling methods, such as open burning or acid leaching, release toxic fumes and pollute ecosystems. At the same time, e-waste represents a missed opportunity: discarded devices contain gold, silver, copper, and rare earth metals that could be reintegrated

into production. The lack of effective recycling results in a double loss—environmental degradation and wasted economic value.

The **social dimension** of e-waste is equally pressing. Much of the waste generated in high-income countries is exported, legally or illegally, to regions in Africa, Asia, and Latin America. Here, informal workers, often including children, dismantle devices without protective equipment, exposing themselves to hazardous chemicals and heavy metals. These practices create serious health risks, such as respiratory illnesses, neurological damage, and long-term chronic diseases. Communities living near informal e-waste sites also suffer from contaminated water sources and reduced agricultural productivity. Thus, e-waste is not only an environmental issue but also one of global justice.

The **circular economy** offers a framework for reversing this trend. Instead of the linear “take, make, dispose” model, it promotes strategies to **reduce, reuse, repair, and recycle**. Reduction means avoiding unnecessary consumption, such as replacing devices before their actual end of life. Reuse involves extending the lifespan of devices through secondhand markets and donations. Repair seeks to fix broken components instead of discarding entire devices. Finally, recycling allows valuable materials to be recovered and reintroduced into new production cycles. Together, these strategies aim to close material loops, conserve resources, and reduce waste.

Europe has already taken steps to embed these principles in policy. The **Right to Repair** initiative obliges manufacturers to make spare parts available for longer periods and to design products that are easier to fix. Eco design regulations encourage modularity and durability, ensuring that products are built to last. Producer responsibility schemes place obligations on companies to collect and recycle devices at the end of their life. These measures reflect a systemic shift towards making sustainability a standard rather than an option.

From the perspective of vocational education and training (VET), e-waste is particularly relevant. Young professionals in fields such as IT, electronics, and engineering need to be trained not only to work with new technologies but also to extend the life of existing equipment and to integrate circular principles into their practice. By equipping learners with the knowledge and skills to reduce digital waste and design repair-friendly solutions, VET becomes a central actor in the transformation towards sustainable digitalisation.



## SOCIAL AND ETHICAL RISKS OF DIGITALISATION

Digitalisation is not only an environmental issue but also a profound social and ethical challenge. The rapid spread of digital technologies has transformed access to information, communication, and services, but it has also generated new risks that affect individuals, communities, and societies as a whole. These risks span from privacy and security concerns to inequality and the erosion of wellbeing. Understanding them is essential if digital transformation is to align with principles of social justice and human rights.

One of the most pressing issues is **cybersecurity and privacy**. The more data societies generate and store, the greater the risk of breaches, identity theft, and surveillance. Vast quantities of personal information are collected through social media, online transactions, and mobile devices. When poorly managed, this data becomes vulnerable to misuse by criminals, companies, or even governments. Mass surveillance practices raise concerns about the balance between security and freedom, particularly when digital tools are used for monitoring populations or influencing democratic processes. These risks demonstrate that digital infrastructures are not neutral: they embody power relations and governance choices.

The **digital divide** is another key challenge. While some groups enjoy constant connectivity and the benefits of advanced technologies, others lack access to reliable internet, devices, or digital literacy. This divide reinforces existing inequalities based on income, geography, age, and education. For example, rural communities often face weaker connectivity, limiting opportunities for online education and remote work. Similarly, older populations or individuals with fewer resources may struggle to acquire the digital skills required to participate fully in the economy and society. Addressing the digital divide is therefore not only a technical issue but also a matter of social equity and inclusion.

The **impact on wellbeing** is also increasingly evident. Constant connectivity and the pressures of digital culture can lead to mental health problems such as stress, anxiety, and screen fatigue. Social media algorithms are designed to maximise engagement, often encouraging addictive behaviours and reinforcing polarisation.

Dependence on digital technologies reduces personal autonomy, as individuals feel compelled to remain permanently online to keep up with social, educational, or professional demands. These challenges remind us that digital transformation is not always synonymous with progress and can undermine the quality of life if not carefully managed.

A particularly **complex ethical issue arises with artificial intelligence (AI)**. Algorithms are trained on large datasets that may contain biases, leading to discriminatory outcomes in areas such as employment, finance, policing, or access to services. Biased data reproduces social inequalities, often in subtle and opaque ways. For instance, automated recruitment systems may unfairly penalise candidates from certain backgrounds, while creditscoring algorithms might discriminate against minority groups. The opacity of AI decisionmaking, often described as the “black box problem,” makes accountability difficult. This raises urgent questions about transparency, fairness, and human oversight in AI systems.

Finally, **the governance of digital technologies** presents a global ethical dilemma. Technology companies often operate across borders, while regulations remain largely national or regional. This creates mismatches between the scale of digital activities and the mechanisms available to ensure accountability. Initiatives like the European Union’s AI Act or the Digital Services Act attempt to address these challenges by setting standards for transparency, safety, and ethical use of digital technologies. However, global coordination remains limited, leaving many risks unresolved.

For vocational education and training (VET), addressing social and ethical risks is critical. Learners need to be aware not only of the technical aspects of digitalisation but also of its broader implications for privacy, equity, and wellbeing. Embedding ethics and responsibility into digital skills training ensures that future professionals are equipped to make decisions that balance innovation with social values. In this way, VET contributes to building a digital society that is not only efficient and innovative but also fair and humane.



## SOME STRATEGIES FOR SUSTAINABLE DIGITAL PRACTICES

The recognition of the environmental, social, and ethical costs of digitalisation must be accompanied by concrete strategies for change. Sustainable digital practices are not a single set of technical solutions, but a multilayered approach that combines technological innovation, organisational policies, cultural transformation, and personal responsibility. By adopting these strategies, societies can align digitalisation with the objectives of the European Green Deal and ensure that technological progress contributes to, rather than undermines, sustainability.

One of the most immediate strategies is the promotion of **digital hygiene**. This involves regular maintenance of digital systems: deleting unnecessary files, uninstalling unused applications, clearing duplicated data, and reviewing storage practices. While these actions may appear minor, their cumulative effect is significant. Millions of unused files stored in cloud servers translate into substantial energy consumption. Encouraging individuals, organisations, and institutions to adopt systematic digital hygiene reduces the burden on data centres and helps minimise digital waste. For companies, embedding digital hygiene into IT policies can also improve cybersecurity by limiting the exposure of outdated or forgotten data.

Another strategy is the development of **efficient storage and data management systems**. This means prioritising compressed file formats, applying expiration dates to stored data, and using collaborative platforms that avoid unnecessary duplication. For example, instead of creating multiple versions of the same file, platforms with version control ensure that only one copy exists. On a larger scale, organisations can implement data governance policies that establish clear criteria for what data should be stored, for how long, and in what format. These measures not only reduce energy use but also streamline organisational efficiency, demonstrating that sustainability and productivity can go hand in hand.

**Responsible videoconferencing and digital communication** are also essential. During the COVID19 pandemic, online meetings became the norm, but their environmental footprint is often overlooked. Highdefinition video streaming requires substantial bandwidth and energy, especially when multiplied across millions of daily meetings. Strategies such as reducing video resolution, switching cameras off when not strictly necessary, and avoiding automatic recordings can dramatically reduce energy use without compromising communication quality. Embedding these practices into institutional guidelines ensures that sustainable choices become standard behaviour rather than optional add-ons.

Extending the **lifespan of digital devices** is a cornerstone of sustainable digital practices. Repairing and upgrading equipment delays the need for new production and reduces the flow of ewaste. Refurbishment and secondhand markets allow devices to be used for longer periods, ensuring that their embedded resources are maximised. Policies such as the European Union's Right to Repair initiative support this approach by requiring manufacturers to make spare parts available and design products that can be easily fixed. For VET institutions, teaching repair and maintenance skills prepares learners to engage directly with circular economy practices and fosters a culture of resource efficiency.

**Conscious consumption** is equally important. This means critically assessing whether new devices or services are truly needed,

and resisting the cultural pressure of constant upgrades. Campaigns such as Digital Cleanup Day illustrate how collective action can change attitudes, reminding individuals and organisations that sustainability also depends on behavioural choices. At the organisational level, procurement policies can favour sustainable suppliers, energyefficient equipment, and modular designs that extend product life. At the personal level, simple choices such as keeping a smartphone for an extra year can reduce the cumulative demand for raw materials and energy.

Finally, sustainable digital practices require **awareness, education, and cultural transformation**. Without widespread understanding of the material impacts of digitalisation, strategies will remain superficial. Embedding sustainability into digital literacy programmes ensures that learners, workers, and citizens understand the consequences of their choices and are empowered to act responsibly. For VET, this is an opportunity to integrate sustainability across curricula, ensuring that future professionals in IT, engineering, and management see digital responsibility as a core competence. This cultural change is not only about reducing environmental impacts but also about reinforcing the values of fairness, responsibility, and resilience in digital societies.

Taken together, these strategies demonstrate that sustainable digitalisation is achievable, but only if it is pursued holistically. Technical improvements such as more efficient servers or renewablepowered data centres are important, but insufficient on their own. They must be combined with behavioural change, regulatory frameworks, and cultural transformation. Only by integrating these layers can societies move towards a digital future that supports the goals of the Green Deal and the twin transition.



## THE EUROPEAN GREEN DEAL AND VOCATIONAL EDUCATION AND TRAINING

The European Green Deal is the flagship strategy of the European Union for achieving climate neutrality by 2050. It establishes a roadmap for reducing emissions, fostering circular economy practices, and protecting biodiversity, while ensuring that the transition is socially fair and inclusive. Digitalisation plays a central role in this vision. On the one hand, digital tools are essential for monitoring emissions, managing renewable energy, and developing smart mobility. On the other, the digital sector itself generates growing environmental and social impacts that cannot be ignored. The challenge lies in aligning the digital transition with the objectives of the Green Deal, creating what the EU calls the twin transition: green and digital at the same time.

The twin transition recognises that digitalisation and sustainability are deeply interconnected. Advanced data systems, artificial intelligence, and the Internet of Things can optimise energy networks, reduce waste, and enable more efficient use of resources. Yet these technologies also consume vast amounts of energy, water, and materials, contributing to climate change and resource depletion. This paradox underscores the need for careful governance: digitalisation must be harnessed as a driver of sustainability, not as an additional source of environmental burden. The EU's policy framework reflects this duality, with measures such as requiring all European data centres to be climate-neutral by 2030, promoting ecodesign standards for digital devices, and regulating the development of artificial intelligence through the AI Act.

Another important pillar of the Green Deal is recycling, which is directly relevant to the digital sector. Initiatives such as the Right to Repair and extended producer responsibility require manufacturers to design devices that last longer, can be repaired, and are easier to recycle. These policies not only reduce the flow of electronic waste but also create new skills demands across the labour market. Technicians capable of repairing, refurbishing, and recycling digital equipment will be in high demand, making this an opportunity for VET to prepare learners for sustainable

jobs. By embedding circular economy principles into training, vocational education becomes a critical tool for implementing Green Deal objectives on the ground.

The Green Deal also emphasises the social dimension of the transition, ensuring that no community or worker is left behind. Digitalisation has the potential to create new forms of inequality if access to devices, connectivity, and skills remains uneven. VET institutions can play a transformative role by equipping learners from diverse backgrounds with ecodigital competences, thereby reducing the risk of exclusion. In this way, VET acts as a bridge between highlevel policy and local realities, translating the ambitions of the Green Deal into practical skills and inclusive opportunities.

For vocational education and training, the implications of the Green Deal are far reaching. Curricula must incorporate knowledge of digital footprints, sustainable practices, and ethical considerations, ensuring that learners are not only proficient in technology but also conscious of its impacts. Teachers and trainers need professional development to integrate sustainability into their teaching methods. Partnerships between VET providers, companies, and public institutions are essential to ensure that training reflects realworld needs. By fostering these collaborations, VET contributes not only to the employability of individuals but also to the resilience and sustainability of entire economies.

In conclusion, the European Green Deal provides a framework for rethinking the digital transition as part of a broader commitment to climate neutrality and social justice. By aligning digital innovation with sustainability goals, Europe seeks to lead a transformation that is both technologically advanced and environmentally responsible. Vocational education and training has a decisive role to play in this process: preparing professionals who can design, implement, and manage sustainable digital systems, and embedding the values of responsibility and resilience into the future workforce. Only through this integration of policy, technology, and education can the twin transition become a reality.



**Activity 1: The Data Cleanup Challenge**

Time: 60 minutes

Objective: To develop digital hygiene skills and reduce digital waste.

Materials: Laptops or smartphones (each student), cleanup checklist prepared by the teacher.

Steps:

1. Introduction (5 min): The facilitator explains the concept of digital waste (unused apps, duplicate files, “dark data”).
2. Personal Audit (15 min): Students review their own devices using the checklist. Tasks include:
  - o Delete unused apps.
  - o Remove duplicate photos and files.
  - o Clean email inbox (unsubscribe from unnecessary newsletters, delete spam).
  - o Check cloud storage for outdated backups.
3. Group Discussion (15 min): In small groups, students calculate how much space they have freed and discuss how these small changes could reduce energy and storage demands if multiplied across society.
4. Sharing Results (15 min): Groups present their total cleaned data (e.g., “Our group deleted 18 GB in total”) and propose three rules for maintaining good digital hygiene.
5. Debrief (10 min): The facilitator connects the activity to the broader environmental and security benefits of reducing digital waste.

Resources: Digital Cleanup Day - [digitalcleanupday.org](https://digitalcleanupday.org).**Activity 2: Role Play – The Life of a Smartphone**

Time: 75 minutes

Objective: To explore the environmental and social challenges in the life cycle of electronic devices.

Materials: UN Global E-waste Monitor; EU “Right to Repair” initiative.

Steps:

1. Introduction (10 min): The facilitator explains that every smartphone has a complex life cycle, involving extraction, production, consumption, and disposal.
2. Role Assignment (10 min): Each student or group receives a role card with background information about their stakeholder.
3. Roundtable Simulation (30 min): Students stage a debate on the production and disposal of smartphones. Each role defends its interests:
  - o Miner: working conditions and economic survival.
  - o Manufacturer: profit and global competition.
  - o Designer: innovation and obsolescence.
  - o Consumer: affordability and performance.
  - o Recycler: lack of facilities and costs.
  - o Policymaker: environmental and social regulation.
4. Negotiation (15 min): Stakeholders are asked to agree on three joint solutions to reduce the smartphone’s footprint.
5. Debrief (10 min): The facilitator highlights tensions between economic, social, and environmental priorities and links the discussion to the circular economy.

Resources: UN Global E-waste Monitor; EU “Right to Repair” initiative. <https://rmis.jrc.ec.europa.eu/ewaste>**Activity 3: Sustainable IT Policy for a VET School**

Time: 60 minutes

Objective: To engage VET students in designing a realistic digital sustainability policy for their own school or training centre.

Materials: Flipcharts, markers, template with policy categories (energy use, devices, storage, awareness).

Steps:

1. Introduction (10 min): The VET Teacher or trainer explains that institutions, not just individuals, can adopt sustainable digital practices.
2. Group Brainstorming (20 min): Groups receive a policy template divided into categories:
  - o Reducing energy (e.g., switch off devices at night, efficient videoconferencing).
  - o Device management (reuse, repair, avoid unnecessary upgrades).
  - o Data storage (delete unnecessary backups, use shared platforms).
  - o Awareness (train staff and students on digital hygiene).
3. Drafting (20 min): Each group develops 2–3 concrete measures for each category and writes them on a flipchart.
4. Presentation (10 min): Groups present their “School Digital Sustainability Charter.” The VET Teacher highlights feasible ideas and links them to the European Green Deal and the twin transition.

Resources:

- European Commission – Digital Education Action Plan. <https://education.ec.europa.eu/focus-topics/digital-education/plan>- EU Green Deal overview (European Commission communication). <https://www.consilium.europa.eu/es/policies/european-green-deal/>

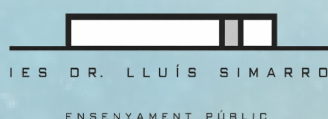


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EDP-VET  
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2024-2-ES01-KA210-VET-000280277



The Project **Eco-Digital Pathways for VET** is an Erasmus+ Project - N° **2024-2-ES01-KA210-VET-000280277**. This co-funded by the European Union. The views and opinions expressed in this publication are those of the author(s) only and do not necessarily reflect those of the European Union or the Spanish Service for the Internationalisation of Education (SEPIE). Neither the European Union nor the National Agency SEPIE can be held responsible for them.