Sustainability, business and plant

Last night you watched a match on your phone. No paper, no petrol, no plastic: digital is clean, right? Somewhere a data centre sent you that video, its servers ran all night, and they were cooled by machines that use electricity and sometimes water. Your phone was made from metals dug out of a mine, and one day it will become electronic waste.

So, are enabling technologies good or bad for the planet? The honest answer is "it depends, and you have to measure it". On islands with limited water and land, and a population that swells every summer, measuring and adjusting consumption matters a lot. This page gives you both faces of the coin, then answers a second question your report needs: where does each technology act, in the offices or on the plant floor, and what does it improve there?

What you will learn

- Explain how enabling technologies help an **efficient** and **sustainable** economy (face A) and what environmental cost they have (face B)
- Recognise the **rebound effect**, the trap of "more efficient means less consumption"
- Place each technology in the **business** side, the **plant** side or both, with an example
- Identify the improvements they bring to **IT** and **OT** environments and to the connection between them
- Measure two real footprints in the browser: the carbon intensity of Mallorca's electricity and the estimated emissions of a website

Efficient and sustainable

> An **efficient** economy gets the same result with fewer resources: energy, water, raw materials, time. A **sustainable** economy does it without compromising the future: environmental, economic and social.

The European Union talks about the **twin transition**: the digital transition and the green transition must move together, because they can reinforce each other, and they can also clash.

Face A: how the technologies help

Technology	What it allows	Effect
IoT + big data	Measure energy and water use in real time; spot leaks and waste	You cannot reduce what you do not measure
AI	**Predictive maintenance** (anticipating failures from sensor data); optimising routes, loads, air conditioning, production	Fewer breakdowns, less fuel, less energy
Digital twins	Simulate a change before making it	Fewer physical tests, fewer costly mistakes
Additive manufacturing	Use material only where needed; print spare parts locally, on demand	Can reduce waste, transport and stock

Technology	What it allows	Effect
Cloud	Share infrastructure among many customers in large data centres	Usually better used than many half-empty servers of your own
Blockchain	Trace the origin of products along the supply chain	Supports the circular economy and transparency

Face B: the cost of digital

Cost	What happens	A number to remember
Energy	Data centres use a lot of electricity, and AI is the main driver of its growth	About 415 TWh, around 1.5% of the world's electricity in 2024 (International Energy Agency)
Water	Depending on the cooling system, data centres also consume water	It varies a lot by site and climate
Materials and waste	Devices need critical raw materials, and constant renewal generates **e-waste**	62 million tonnes of e-waste in 2022, only 22.3% documented as properly collected and recycled (ITU and UNITAR)

> The **rebound effect** happens when making something more efficient and cheaper leads people to use more of it, so total consumption can end up rising.

> **Careful: "digital is always greener"**
> An app that saves paper but runs on servers switched on all day is not automatically more sustainable. Neither is it automatically worse. The only honest answer is to **measure** both sides, which is exactly what you will do in class today.

Business or plant?

Remember Unit 1: the **business** side is the offices, management and customer relations (IT systems); the **plant** side is where the product is made or the service is physically delivered (OT systems). In the city-builder, the city hall and the infrastructure.

Technology	In the business	On the plant
IoT	Product usage data for sales and after-sales	Sensors on machines, installations, vehicles
Cloud	ERP, CRM, email and collaboration tools as a service	Platform where plant data are sent and analysed
AI	Sales forecasts, chatbots, fraud detection	Quality control by camera, predictive maintenance
Big data	Customer and market analysis	Analysis of process and production data
Cybersecurity	Protecting customer data and management systems	Protecting control systems: stopping them stops the plant
Blockchain	Contracts and certificates	Traceability of batches and raw materials
Robotics	Software robots (RPA) for admin tasks	Industrial robots, cobots, mobile robots
Additive manufacturing	Prototypes for design and marketing	Spare parts, tools, short runs
AR / VR	Sales demos, virtual visits	Maintenance assistance, operator training
5G	Mobile work	Wireless connection of machines, vehicles, sensors

Technology	In the business	On the plant
Digital twins	Simulating scenarios to decide investments	Replica of the line, the machine or the building

What they improve in IT and OT

Improvements in IT	Improvements in OT	Improvements from connecting IT and OT
Scale resources with demand; automate repetitive tasks; decide with data instead of intuition; work from anywhere	Fewer unplanned stops; more quality and less scrap; safer work for people; remote supervision and control	The business sees the plant in real time; the plant produces according to real demand; traceability from the order to the product

An improvement only counts if you can check it. That is why every improvement in the report needs a **KPI** (key performance indicator): one number you would measure before and after. “Fewer stops” is vague; “unplanned stop hours per month” is a KPI.

In class: measure the footprint

Three short tasks in the browser, handed in as one document on Classroom (class activity, individual). These tools only look at public information, as any visitor does: **passive only**. **No AI tools.**

Step	Do this	You should see
1	Open Electricity Maps (`app.electricitymaps.com`), find the zone **Mallorca** and then **Spain** (mainland)	The carbon intensity of each, in gCO_2eq/kWh, and the mix of sources right now
2	Write both numbers, the time, and the main source in each	Two different numbers: an island grid and a mainland grid are not the same
3	Open the Website Carbon Calculator (`websitecarbon.com`) and test your company’s home page	Grams of CO_2 per visit and whether the hosting appears as green
4	Check the same domain with the Green Web Foundation’s Green Web Check	Whether the hosting provider is listed as running on green energy
5	Write two sentences: what the numbers suggest, and why they are estimates and not exact measurements	The calculator estimates from the page weight and average grid figures

Then, for each technology of your section of Deliverable 2, write:

Field	What to write
Business or plant	Business, plant or both; the exact department or process
Sustainability	One benefit and one cost, and what you would measure
IT / OT improvement	Which environment (IT, OT or the connection) and one KPI

For your project

The three fields you just wrote are fields 3, 5 and 6 of your technology sheets in Deliverable 2 (criteria e, c and f). The two measurements of today are good evidence to quote in field 5: a real number with its source and date is worth more than a paragraph of good intentions. If your company publishes a sustainability report, cite it; if not, write that you looked for it and did not find it.

Key takeaways

- **Efficient** means the same result with fewer resources; **sustainable** means without compromising the future. The EU calls doing digital and green together the **twin transition**.
- Face A: IoT, data and AI measure and optimise consumption; **predictive maintenance**, digital twins and additive manufacturing reduce waste.
- Face B: data centres used about 1.5% of the world's electricity in 2024, and only 22.3% of the 62 million tonnes of **e-waste** of 2022 was documented as recycled.
- The **rebound effect** can turn efficiency into more total consumption: measure, do not assume.
- Every technology acts on the **business** side, the **plant** side or both, and improves IT, OT or the connection between them.
- An improvement needs a **KPI**: one number you would measure before and after.

Quick check

1 What is predictive maintenance?

A Repairing machines only after they break
B Replacing every part once a year, whatever its state
C Anticipating failures from sensor data before they happen
D Buying a new machine every five years

2 A company makes its delivery app so efficient that each delivery costs much less, and customers order three times as often. Total fuel use goes up. What is this called?

A Twin transition
B Rebound effect
C Servitisation
D Predictive maintenance

3 Which statement about the environmental cost of digital technologies is correct?

A Digital technologies have no environmental cost because they are virtual
B Data centres use electricity and sometimes water, and devices become e-waste
C Only cryptocurrencies consume energy
D All e-waste is recycled in Europe

4 Which one is an enabling technology on the business side?

A A cloud CRM with AI that ranks which customers to call first
B IoT sensors watching the temperature of an oven
C A cobot that palletises boxes
D A 5G network connecting cranes in a port

5 Which improvement belongs to the OT environment?

A Scaling servers with demand without buying hardware
B Fewer unplanned machine stops
C Working from home with cloud tools
D Faster approval of invoices

6 A student writes as the improvement of a technology: “It will make the company more efficient.” What is the best advice?

- **A** It is perfect: efficiency is the goal
- **B** Name the process and add a KPI you would measure before and after, such as litres lost per day
- **C** Remove it: reports should not talk about improvements
- **D** Add more technologies so the improvement is bigger

7 Your company’s website shows a high CO_2 figure per visit in the Website Carbon Calculator. Pick the two sensible conclusions.

- **A** It is an estimate based on the page weight and average figures, not an exact measurement
- **B** It proves the company pollutes more than all its competitors
- **C** Making the page lighter (smaller images, fewer scripts) would probably lower the estimate
- **D** The company must be breaking the law

You now have every piece of the technology report. The last lesson is about putting it together well: finding sources you can trust, citing them and writing it as a team. Next: Writing the technology report.

Solutions

1. C · **Predictive maintenance** uses IoT data and analysis (often AI) to fix a machine just before it would fail: fewer breakdowns and less waste than repairing late or replacing early.

2. B · When efficiency makes something cheaper and people use much more of it, total consumption can rise: the **rebound effect**.

3. B · Face B is real: about 1.5% of the world’s electricity went to data centres in 2024, and most **e-waste** is not documented as properly recycled.

4. A · The **CRM** serves sales and customer relations: offices, IT. The other three act on the physical operation: the **plant**.

5. B · Unplanned stops happen on the plant floor, so it is an **OT** improvement. The other three are IT improvements.

6. B · An improvement only counts if it can be checked. A **KPI** turns a vague promise into something the company can measure.

7. A, C · The calculator **estimates** emissions from data transferred, so a heavier page scores worse. It is useful for comparing and improving, not as proof of anything.