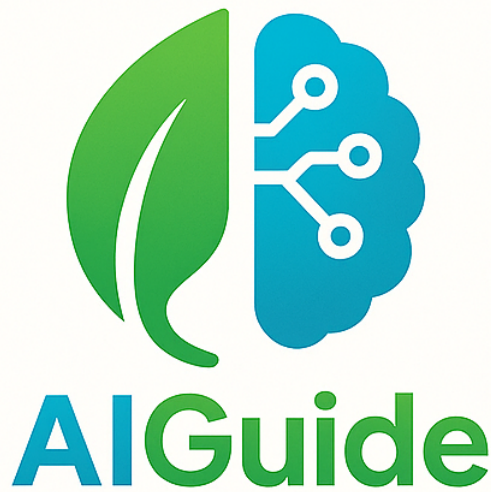




ONLINE COURSE CONTENT

MODULE 4: REAL-LIFE EXAMPLES, CASES AND SCENERIOS TO UNDERSTAND GREEN DECISION-MAKING

2025-1-LT01-KA220-HED-000354784

Artificial Intelligence for Green Understanding, Insights & Decision Empowerment



SQUAREDEV



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A. General Information

Module No	Module 4
Subtopic	4.1. Real-life examples, cases and scenarios to understand green decision-making
AI Literacy Component	AI-supported case analysis; best-practice interpretation; real-world environmental decision-making examples
Decision Making Skills	Case analysis; contextual judgement; comparison of practical green decisions
Learning Objectives for STEM HE Teachers	Analyse real-life industrial and environmental cases to identify how AI supports green decision-making.
Learning Objectives for STEM Students	Interpret authentic cases and discuss how AI can affect green choices.
Suggested AI Tools	ChatGPT, Claude, Microsoft Copilot, Perplexity AI, Llama, Poe
Estimated Duration	60 minutes

B. Content for STEM HE Teachers

Real-life examples, cases and scenarios to understand green decision-making

Highlights

- Artificial Intelligence can be used as a decision-support tool for addressing real-world sustainability and environmental challenges.
- The characteristics of effective green decision case studies and the key elements of their analysis include context, available evidence, AI applications, and decision alternatives.
- Contextual judgement, human expertise and ethical aspects are important when interpreting AI-supported recommendations.
- Reliable sources of environmental data, scientific evidence and industrial information are required for developing authentic case studies.
- There are practical examples demonstrating how AI contributes to evidence-based decision-making through different sectors and sustainability contexts.

Introduction

Artificial Intelligence (AI) is becoming an important decision-support technology for sustainability. AI is increasingly being applied to sustainability-related problems, including analysing large datasets, predicting environmental outcomes, optimising resource use, and recommending sustainable actions. (Kumar Kar et al., 2022)

Check this video about discussing the role of AI in tackling climate change: [Sims Witherspoon \(2023\)](#)

However, human responsibility, oversight and accountability in AI-related decision-making remain relevant. (UNESCO, 2022) AI can support professionals by identifying patterns that would be difficult to detect manually. Human expertise remains essential for interpreting AI recommendations, considering ethical implications, and balancing environmental, economic, and social priorities.

For higher education (HE) teachers, real-world cases provide an effective way to demonstrate how AI contributes to solving sustainability challenges. Rather than teaching AI algorithms in isolation, authentic case studies encourage learners to analyse complex situations, evaluate alternative actions, and understand why different decisions may be appropriate under different conditions.

Green Decision Context

Real-life examples are among the most effective teaching tools for developing decision-making skills; they can bridge the gap between theoretical concepts and practical decision-making. (Mu-Hatch, 2024) Environmental-related problems rarely have a single "correct" solution. Instead, decisions require balancing environmental, economic, technological, and social considerations under conditions of uncertainty. (Committee on Decision Making Under Uncertainty, 2013) AI can process large amounts of data, identify patterns or predict outcomes, but human expertise remains essential for interpreting recommendations, considering local contexts, and making responsible decisions.

Check this video about Google's AI tool for flood forecasts: [Google Research, 2025](#)

STEM higher education teachers can use authentic case studies to help students move beyond learning about AI to understanding how AI supports evidence-based green decision-making in practice. Analysing real cases encourages students to evaluate multiple sources of information, question AI-generated recommendations, and compare alternative sustainability strategies.

Case studies provide a valuable approach for examining complex real-world situations within their authentic contexts, allowing researchers and educators to explore the interactions between multiple influencing factors. The emphasis on context, multiple sources of evidence, and in-depth analysis makes it particularly valuable for exploring situations where interactions between social, organisational, or environmental factors cannot be fully understood through isolated observations alone. In addition, comparative case study is a research approach that examines two or more cases to identify similarities, differences, and broader patterns. It can be used for descriptive, exploratory, or explanatory purposes and may involve either qualitative or quantitative analysis. Unlike studies that focus on unique or exceptional cases, comparative case studies can investigate cases with sufficient shared characteristics to support meaningful comparison. (Mills et al., 2010)

The main steps to develop real-life examples are the following:

- Case analysis: Identify the environmental challenge, stakeholders, available data, AI methods, and possible solutions.
- Contextual judgement: Evaluate whether an AI-supported solution is appropriate for a specific location, sector, organisation or community.
- Comparison: Compare alternative decisions based on environmental, economic, and social outcomes, recognising that different contexts may require different solutions.

Why Use Real-Life Examples?

Real-life cases expose students to the complexity of sustainability challenges that professionals face. The case method promotes active learning by engaging students in realistic situations, while developing analytical, decision-making, communication, and teamwork skills, encouraging learners to apply knowledge to complex, real-world problems. (Herreid, 1994) Unlike textbook examples, authentic cases often include incomplete information, competing priorities, and uncertainty; conditions under which AI is increasingly used as a decision-support tool. Using real-world examples can enable students to:

- link theoretical concepts with industrial and environmental practice;
- understand how AI analyses multiple data sources (e.g., sensor data, satellite imagery, weather forecasts, energy consumption records);
- recognise that, in decision-support applications, AI provides recommendations rather than final decisions;
- appreciate the importance of human control, ethical aspects, and local knowledge;
- improve critical thinking by questioning assumptions, data quality, and the reliability of AI outputs.

Authentic cases encourage critical interpretation instead of memorising examples. (Amelia et al., 2024) Cases can demonstrate that identical AI technologies may lead to different decisions depending on local environmental conditions, organisational priorities, regulations or stakeholder expectations.

For example, an AI system designed to optimise irrigation may recommend increasing water use during an unusually dry growing season. In one region, where water resources remain sufficient, this recommendation may improve crop yields while maintaining sustainability. In another region experiencing severe drought, the same recommendation may be environmentally unacceptable. The case illustrates that AI recommendations must always be interpreted within their environmental, economic and social context.

Similarly, AI may identify the shortest waste collection route for a municipality. However, local authorities may adjust the recommendation because of roadworks, school zones, public events or safety regulations. Such examples help explain that AI delivers valuable evidence, while human decision-makers remain responsible for evaluating practical feasibility and wider sustainability objectives.

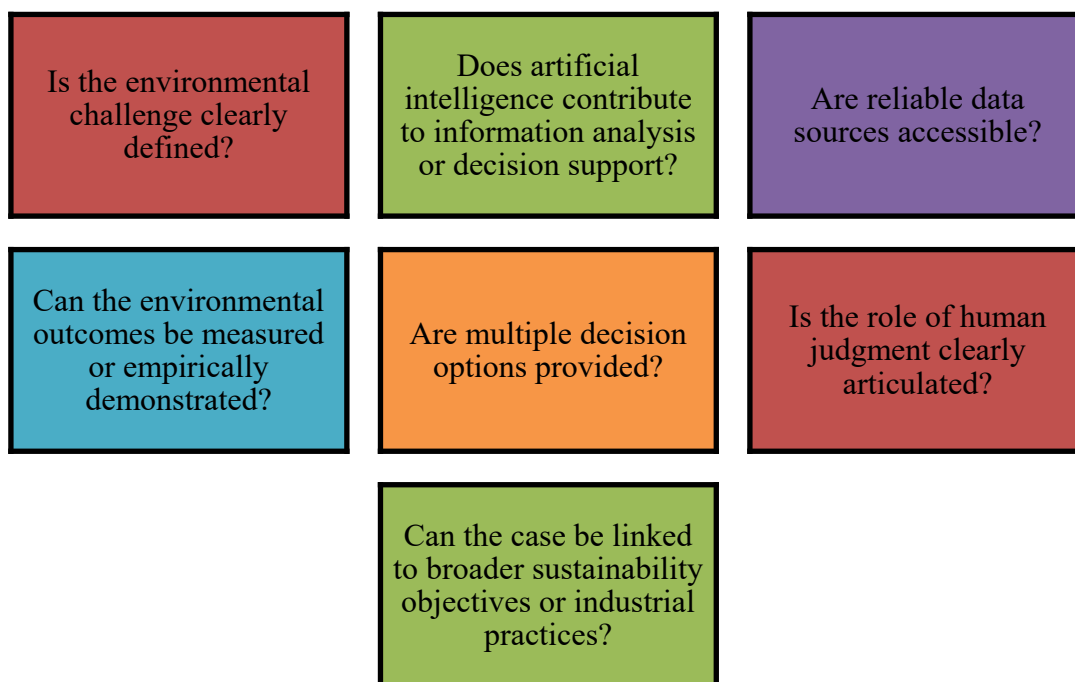
Developing New Case Studies

There are publicly available or paid online sources presenting case studies of AI in green decision-making, such as:

- Coalition for Sustainable AI (2026): AI for Green Initiatives (Inventory for use cases). Available: <https://www.sustainableaicoalition.org/inventory-of-use-cases/>
- World Economic Forum (2025): Digital twin grid. Available: <https://initiatives.weforum.org/future-power-system/case-study-details/digital-twin-grid/aJYTG00000010pB4AQ>
- Eddie TSUI, CESGA (2024): 10 Case Studies on Using AI to Improve Sustainability Efforts. Medium. Available: <https://medium.com/@eddie.hc.tsui/10-case-studies-on-using-ai-to-improve-sustainability-efforts-92b0d3ee4ac5>

- Business for Social Responsibility: Looking Under the Hood: ORION Technology Adoption at UPS. Available: <https://www.bsr.org/en/case-studies/center-for-technology-and-sustainability-orion-technology-ups>

In addition to published case studies, valuable examples may be derived from publicly available industrial reports, government initiatives, scientific publications, or international sustainability projects. When selecting or developing a case, higher education (HE) educators should consider the following criteria:



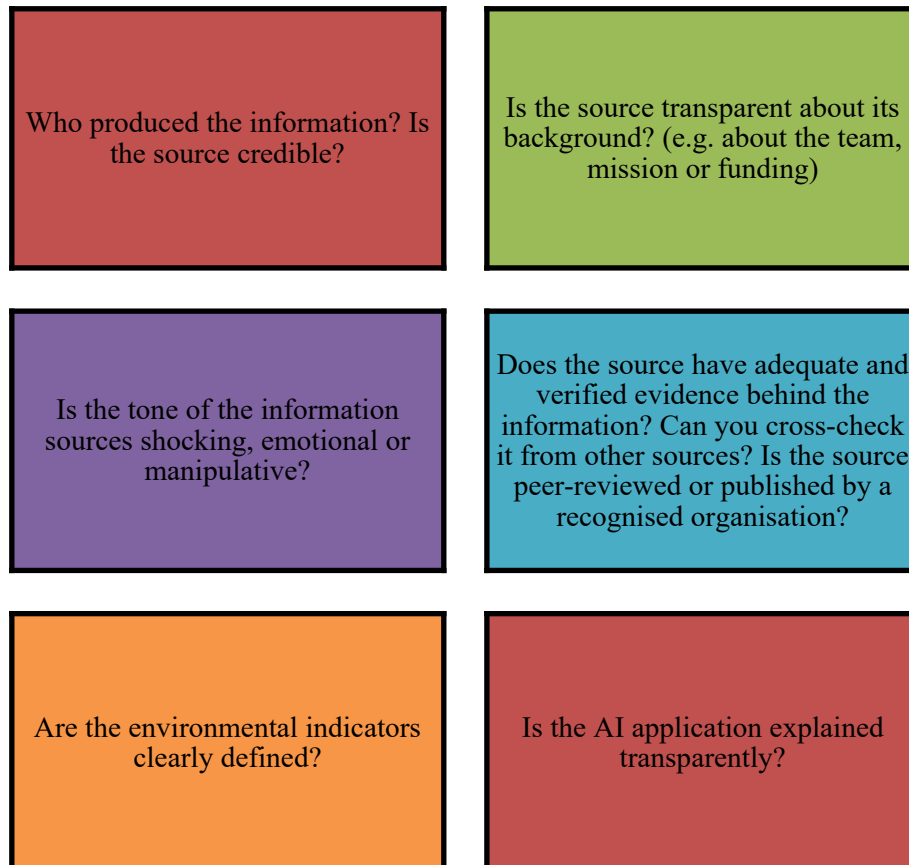
Reliable information

High-quality case studies depend on trustworthy evidence. Teachers should prioritise information from recognised scientific, governmental and international organisations rather than relying solely on commercial marketing materials or news articles.

Scientific literature	Web of Science, Scopus, IEEE Xplore, ScienceDirect, SpringerLink etc.
Industrial reports and articles	Sustainability or Environmental, Social and Governance (ESG) reports
Reports and other publications of international organisations	United Nations Environment Programme (UNEP), Food and Agriculture Organisation (FAO), International Energy Agency (IEA), World Meteorological Organisation (WMO), Organisation for Economic Co-operation and Development (OECD) etc.
European Union and governmental sources	European Commission, European Environment Agency (EEA), Eurostat, National environmental agencies, National statistical offices etc.

Test your media literacy and critical thinking in these digital escape rooms: [SPOTit, 2023](#)

When using external data and information, verification is an important part of the case development. Quality assurance and cross-check of information from multiple independent sources helps ensure that case studies remain balanced, credible and academically robust. (Suleiman et al., 2008) Critical evaluation of the inputs can be completed by the following questions (European Commission, n.d.):



Structure

A well-developed case study should present a realistic decision context and clearly explain the relationship between environmental challenges, available data, AI analysis, and the final decision. Effective case analysis usually includes the following components:

- Context: Describe the organisation, industry, or specific environmental problem, as well as the relevant stakeholders.
- Sustainability challenge: Explain the question which required a green decision (e.g., reducing emissions, improving resource efficiency, protecting ecosystems).

- Available data: Identify the environmental, operational or social data used during decision-making.
- Role of AI: Present what AI tool was used and explain how AI analysed the available information or supported predictions, optimisation or classification.
- Decision alternatives: Present different feasible actions rather than a single solution.
- Final decision: Describe the selected option.
- Outcomes: Summarise environmental, economic and, where relevant, social impacts.
- Limitations: Discuss uncertainties, assumptions, ethical considerations or cases where human judgement remained essential.

As part of the contextual judgement, evaluation of the presented case and its lessons learned can highlight the adaptability of the solutions in other cases, organisations, sectors, countries, or regions. If possible, similar cases should be compared with each other to identify common elements, understand environmental, technological and social differences, and support adaptability.

AI tools

AI tools can help you find, develop and analyse case studies, for example:

- ChatGPT (OpenAI): Analyse sustainability cases, compare AI recommendations, generate discussion questions
- Google Gemini: Summarise environmental reports and explain AI-supported decisions
- Microsoft Copilot: Interpret datasets and prepare case summaries
- Perplexity AI: Search for evidence with cited sources
- Consensus AI: Find scientific literature supporting case studies
- Poe: Support comparing different alternatives.

Check the Best Practices Report for more information about the tools.

Case Study Example

SOCAR Carbamide in Azerbaijan

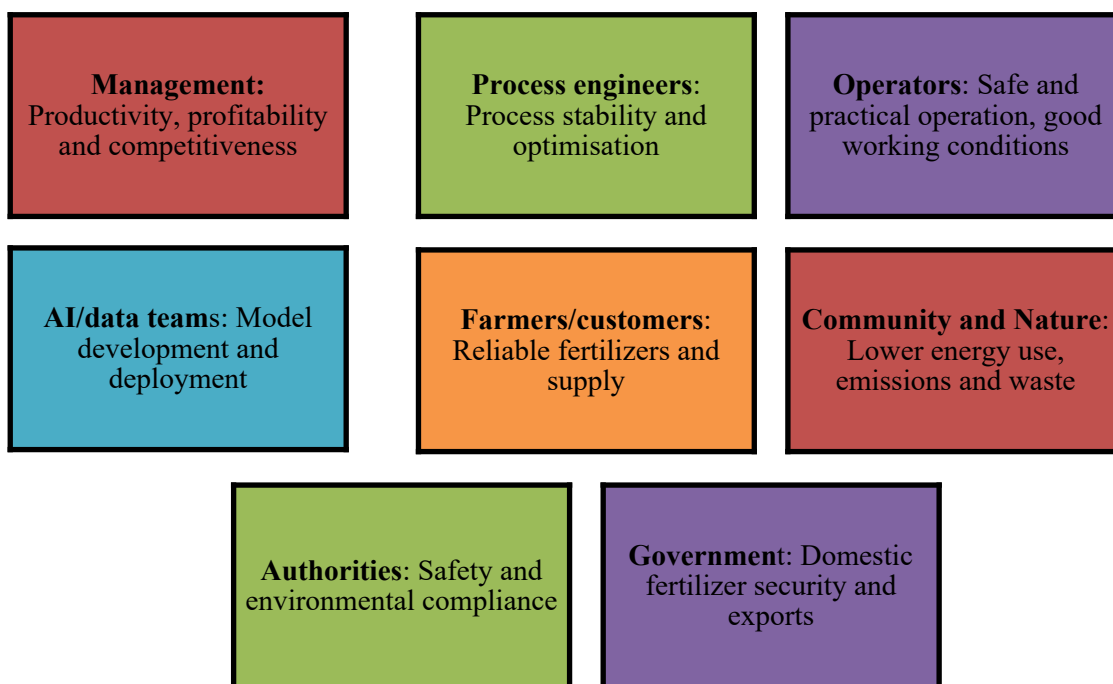
1. Context

SOCAR is Azerbaijan's state-owned energy company, with activities spanning oil and gas, refining, chemicals, transportation, distribution and other energy activities. SOCAR Carbamide is its fertiliser-production facility in Sumqayit. The plant produces ammonia and urea (carbamide) using natural gas as an important feedstock and energy input. Urea is an important agricultural ingredient, but its production is energy-intensive. Consequently, improving the efficiency of the process can have both economic and environmental implications.

The plant was commissioned in 2019. The International Energy Agency reported that, at planned production levels, the facility was expected to consume around 435 million m³ of natural gas per year to produce approximately 400 kt of ammonia and 650 kt of urea.

The plant was operating close to its practical capacity while facing pressure to improve productivity and energy efficiency. The World Economic Forum describes the context as one in which geopolitical disruption had complicated fertiliser supply chains and access to natural gas. The transformation therefore had several simultaneous objectives: increase production; use natural gas more efficiently; improve process stability; reduce waste; reduce downtime; improve operational decision-making; develop employees' digital capabilities.

The most relevant stakeholders and their interests can be mapped as follows:



Tip for teachers	
	- Present the case to the students firstly only briefly: <i>A fertilizer plant is operating close to capacity. It wants to produce more while using less natural gas per tonne of product. What are the main concerns and challenges they face?</i> - Build stakeholder map together with the students. Who should be involved in making this decision to find a solution?

2. Sustainability challenge

How can SOCAR Carbamide increase or maintain production while reducing the amount of natural gas and other resources required for each unit of fertilizer produced?

This is particularly significant because natural gas is both an important input to ammonia/urea production; and associated with greenhouse-gas emissions.

The challenge: Produce the required quantity and quality of fertilizer while minimising energy/resource consumption and maintaining safe, stable operation. Increase output, while

reducing natural gas consumption per tonne, GHG emissions, waste and unplanned downtime, while maintaining safety, quality and process stability.

	Tip for teachers • Discuss possible solutions with the students. Which specific performance figure or process element should be targeted and considered? • Then ask: What happens if the AI only optimises gas consumption? Students should recognise that an unconstrained optimisation could produce an operationally unacceptable solution.
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3. Available data

SOCAR's transformation built on an extensive digital infrastructure already present in the plant. According to McKinsey, the EnergyAI system analyses hundreds of energy-network variables in real time and runs up to two million simulations to identify efficient operating conditions. Other reporting on the plant describes AI systems analysing thousands of real-time process signals and using information from the plant's existing Advanced Process Control infrastructure.

For the identified challenge, different types of data need to be analysed:

- Energy: Natural-gas consumption, electricity consumption
- Process: Temperature, pressure, flow rates
- Production: Production volume, throughput, product quality
- Equipment: Equipment condition and operating parameters
- Utilities: Steam and energy-network conditions
- Maintenance: Equipment performance and failure history
- Environmental: Gas consumption, emissions and waste
- Operational: Control settings and process deviations
- Historical: Previous operating states and outcomes

	Tip for teachers • To better understand data, give students examples of variables related to the list above and ask them to categorise as input, prediction target, control variable, constraint or sustainability KPI. • Ask students to give examples for environmental variables which are necessary for the decision-making. E.g. water consumption, methane leakage or waste streams.
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4. Role of AI

The SOCAR case involves several AI applications rather than one single model.

EnergyAI — optimisation AI + simulation + optimisation McKinsey describes EnergyAI as a no-code energy-network optimisation system. • receives hundreds of real-time variables; • analyses the state of the energy network; • runs up to two million simulations; • identifies efficient operating conditions; • recommends optimal set points. SOCAR reported a 24% improvement in natural-gas efficiency.	AI-based production optimisation Real-time prediction → optimisation → process adjustment The plant also implemented an AI-based production variability optimisation system. • continuously monitors key metrics; • can adjust more than 150 control settings Combined with operational changes, the system increased throughput by 21% and reduced yield losses.
Predictive maintenance Better prediction → fewer unexpected failures → less downtime → potentially more efficient resource use Reporting from the plant describes systems analysing information such as temperature; pressure or flow. The system can identify potential equipment problems in advance and generate maintenance tasks.	Generative AI and workforce support AI + human expertise + industrial automation The broader programme also used generative AI to support employees. The WEF reports that the transformation involved 42 digital use cases, including workforce support with generative AI and robotics.

	Tip for teachers • Ask students: “Which of these applications has the strongest direct sustainability impact?” There is no single correct answer, students must defend their interpretation.
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5. Decision alternatives

Alternative A — Continue conventional optimisation Use existing automation and engineers to optimise the plant manually. Advantages	Alternative B — Invest primarily in physical equipment Instead of AI, invest in new equipment such as pumps; compressors; heat exchangers; process equipment; or energy-efficiency hardware.
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• proven approach; • familiar to operators; • relatively low AI risk. Disadvantages • difficult to analyse hundreds of variables simultaneously; • human optimisation is time-consuming; • difficult to continuously simulate large numbers of operating configurations.	Advantages • potentially substantial physical efficiency improvements; • engineering effects may be easier to quantify. Disadvantages • high capital cost; • long implementation time; • plant shutdowns may be required; • does not necessarily optimise the operation of existing equipment.
Alternative C — AI decision support Deploy AI that analyses the plant and recommends optimal operating conditions while operators retain control. Advantages • relatively rapid deployment; • combines AI and human expertise; • lower autonomy risk. Disadvantages • operators remain responsible for implementation; • recommendations may not always be trusted; • potential delay between recommendation and action.	Alternative D — Integrated AI + automation Combine: • AI optimisation; • Advanced Process Control; • predictive maintenance; • robotics; • generative AI; • workforce development. This is broadly the approach ultimately adopted by SOCAR Carbamide. Advantages • addresses multiple operational problems; • supports continuous optimisation; • combines different AI capabilities; • potentially scalable across the plant. Disadvantages • greater technological complexity; • greater dependence on data; • higher governance requirements; • workforce transformation required.



	Tip for teachers • Ask students/groups to select one alternative before explaining what SOCAR actually did. Require them to score each alternative from 1–5 for: environmental benefit; capital cost; implementation speed; operational risk; scalability; and workforce impact. • Then, discuss with the students: “Does the environmentally strongest option remain the strongest when all criteria are considered?” This can introduce the method of multi-criteria decision analysis (MCDA).
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6. Final decision

SOCAR ultimately pursued the integrated digital/AI transformation. In 2023, SOCAR and McKinsey began a major digital transformation programme at the plant. Over less than 3 years, they developed 42 digital and AI solutions addressing production, energy efficiency, maintenance and workforce support. The programme included:

- AI-based optimisation;
- Advanced Process Control;
- energy-network optimisation;
- predictive maintenance;
- robotics;
- generative AI;
- workforce digital-skills development.

According to McKinsey, EnergyAI, a no-code AI-supported energy-network optimisation system, was designed to recommend optimal set points by analysing hundreds of variables and simulating up to two million possible operating conditions. The WEF describes the resulting system as supporting closed-loop autonomous process control, while also strengthening workforce capabilities.

The system recommends optimal set points and was reported to improve natural-gas efficiency by 24%. The World Economic Forum reports that the broader transformation increased production throughput by 21% and improved natural-gas efficiency by 24%.

	Tip for teachers • Discuss with students the human–AI decision boundary. “Where would you place the boundary?” Ask them to define clear roles for humans and AI, such as detecting patterns, predicting, defining objectives or establishing constraints.
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7. Outcomes



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According to WEF and SOCAR-related governmental reporting, the transformation produced:

Indicator	Reported change
Production throughput	+21%
Natural-gas efficiency	+24%
Carbon emissions	−19%
Process waste	−72%
Unplanned downtime	−82%
Employees receiving new skills	~70%

Regarding absolute resource savings, a 2025 report from the plant stated that, in 2024, its combined digital initiatives generated approximately:

- \$13 million in additional value;
- 7 million m³ of natural gas saved;
- 1.5 million kWh of electricity saved;
- 70,000 tonnes of water conserved.

It is also important to note that the figures should not be assumed to have evidential status. The WEF case provides stronger independent institutional corroboration for some headline results, while several additional figures are reported through SOCAR/Azerbaijani sources. They are rather reported figures, instead of independently audited information.

	Tip for teachers
	• Interpret the data with the class. Students should notice that the metrics measure different things. E.g. throughput is not an environmental indicator by itself; gas efficiency is an efficiency indicator; process waste is a resource-efficiency outcome etc. The strength of the case is not one single number. It is the interaction of operational, environmental and social improvements. • Ask students: “Which of these outcomes is actually caused by AI?” This is a deceptively difficult question as we cannot attribute every outcome to AI alone; automation, process-control improvements, robotics, organisational-level changes, workforce training and other interventions were also included.

8. Limitations

AI was not the only intervention

This is probably the most important limitation. SOCAR deployed a portfolio of 42 digital and AI solutions, together with changes in operating practices, workforce capabilities and process control. Therefore, it would be incorrect to say that AI alone caused the 21% productivity improvement or 19% emissions reduction. The appropriate formulation is: “SOCAR reports these improvements following an integrated digital and AI transformation.”

Attribution of environmental benefits

A 24% improvement in natural-gas efficiency does not automatically mean a 24% reduction in absolute greenhouse-gas emissions. If production increases substantially, total energy use could potentially rise even while energy use per tonne falls. Therefore, it is important to distinguish absolute impact (e.g. total emissions) from intensity (e.g. emissions per tonne).

Data dependency

AI optimisation depends on sensor quality; historical data; process measurements; reliable control systems; and appropriate model assumptions. A faulty sensor could potentially lead to a faulty recommendation.

Adaptability

A model developed for SOCAR Carbamide may not transfer directly to another fertilizer plant; another ammonia process; another country; another gas composition or different equipment. Industrial AI is highly dependent on the specific physical system and operating environment.

Safety and accountability

The plant uses AI in an industrial chemical environment. An optimisation that saves energy but creates an unsafe pressure or temperature condition would not be acceptable. Therefore AI must operate within engineering constraints.

Workforce implications

Around 70% of employees reportedly acquired new skills during the transformation. This is an important counterpoint to the common assumption that industrial AI necessarily means job elimination. Instead of “Will AI replace workers?”, the relevant question should be “What skills do workers need when AI becomes part of industrial decision-making?”.

AI's own environmental footprint

The AI system itself consumes energy and resources. Therefore, the sustainability assessment should ideally consider the benefits from optimisation minus environmental costs of AI infrastructure (e.g. computing, sensors, data storage, hardware etc.)

	Tip for teachers
	- Discuss with the students: “Who is responsible when an autonomous industrial control system makes a wrong decision?” Possible answers include plant management, engineers, AI developers, operators, the organisation. Students should recognise that technical autonomy does not eliminate organisational accountability. - Give students a deliberately provocative statement: “SOCAR proves that AI makes industrial production sustainable.” Ask them to argue FOR and AGAINST the statement.

References for the case study:

World Economic Forum (2026): *SOCAR Carbamide – Sumqayit – Productivity*. Available: <https://initiatives.weforum.org/navigating-global-value-chain-disruption/case-study-details/socar-carbamide---sumqayit---productivity/aJYTG00000018Jh4AI>

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Recommended Readings

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- UNESCO (2022): Recommendation on the Ethics of Artificial Intelligence. SHS/BIO/PI/2021/1. Available: <https://unesdoc.unesco.org/ark:/48223/pf0000381137>

Videos/Interactive Resources

- Google Research (2025): Before Rivers Rise | Using AI to Make Global Flood Forecasts. Available: <https://www.youtube.com/watch?v=iZmltPAFhY0&t=1s>
- Sims Witherspoon (2023): Can AI help solve the climate crisis? TED Countdown Summit, July 2023: https://www.ted.com/talks/sims_witherspoon_can_ai_help_solve_the_climate_crisis
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