01 | M4 Make your project sustainable

Extra resources for module 4

C01 ENERGY SOURCES MINIMIZING THE CARBON FOOTPRINT. Ability to qualitatively analyze the carbon footprint associated with different energy sources. Energy principles, comparison variables.

1. **Report chapter:** *IPCC Sixth Assessment Report, Chapter 6: Energy Systems.* Provides the scientific basis for analyzing and comparing the carbon footprints of different energy sources.
2. **Practical guide**: *Carbon Trust Guide to carbon footprinting for business*. Introductory guide designed to help businesses understand organisational and product carbon footprinting.
3. **Data dashboard on low-carbon energy transition**: *IRENA Energy Transition Tracker*. An open database and platform providing vital energy data for different zones around the world.
4. **Report:** *IEA Net Zero by 2050: A Roadmap for the Global Energy Sector.* IEA Report presenting a detailed global roadmap for achieving a net zero energy system by 2050.

14S: PROBLEM SOLVING. Complex problem-solving skills.

1. **Journal article:** *Project-Based Problem Learning: Improving Problem-Solving Skills in Higher Education Engineering Students* Paper discusses the essential problem-solving skills in engineering education, encompassing analytical thinking, creativity, and decision-making.
2. **Journal article:** *Developing Complex Problem-Solving Skills: An Engineering Perspective* Presents a blended-learning course design that includes didactic methods for teaching complex problem-solving, integrated with software integration topics.
3. **Journal article**: *Problem-Based Learning and Engineering Education for Sustainability: Where we are and where could we go?* Discusses how problem-based learning (PBL) can be effectively used to teach sustainability in engineering education, highlighting current practices and future directions.

15S: CRITICAL. Critical thinking skills

1. **Review article:** *Critical thinking to embed sustainability in engineering courses activities: A systematic Literature Review* Explores the current trend in engineering studies to include sustainability through critical thinking.
2. **Tool:** *Kialo* A free platform that facilitates structured debates, allowing students to engage in reasoned discussions on complex topics.
3. **Toolkit**: *Sustainability Toolkit: Teaching tools* Toolkit from the Engineering Professors Council that includes learning activities that incorporate critical thinking skills.
4. **Policy paper:** *OECD Report on Decarbonising Maritime Transport.* Report examines what would be needed to achieve zero CO2 emissions from international maritime transport by 2035.

C02. ENVIRONMENTAL EFFECTS OF TRANSPORTATION. Ability to apply engineering knowledge, experience, and innovation to transport, logistics, freight transport, passenger transport, and tourism.

1. **Policy pap**er: *OECD Report on Decarbonising Maritime Transport.* Report examines what would be needed to achieve zero CO2 emissions from international maritime transport by 2035.
2. **EEA Resources:** *Transport and mobility*. Various resources from the EEA on European initiatives to decarbonise the transport sector.

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Toolkit: *Sustainability Toolkit: Teaching tools* Toolkit from the Engineering Professors Council that includes learning activities that incorporate critical thinking skills.

C03: SUSTAINABLE AND RESILIENT INFRASTRUCTURES AND CITIES. Ability to develop sustainable and resilient infrastructure and city models, identifying and understanding the risks posed by climate change, implementing sustainable mobility strategies; distributed renewable energy generation; circular supply chains; and nature-based solutions and forward-thinking scenarios.

1. **UN Report:** *World Cities Report 2024: Cities and Climate Action*. Report provides an analysis of the current and expected climate impacts on different regions and cities.
2. **Case studies**: *C40 Knowledge Hub*. Various practical resources to help cities act on climate change.
3. **Guidance on the implementation of local and regional circular economy initiatives:** *Circular Cities and regions initiative.*
4. **Guidance and practical tools:** *ICLEI Resilience and Climate Adaptation resources.*
5. **OERs**: SDG Academy. Free educational resources, including a course on sustainable cities

03S: MATERIALS. Skills for selecting sustainable materials.

1. **Report/case studies:** *Sustainable Materials Selection in Manufactured Products A Framework for Design-Integrated Life Cycle Thinking with Case Studies* Provides case studies on sustainable material selection, offering a framework for design-integrated life cycle thinking in manufacturing.
2. **Journal article:** *Sustainable manufacturing: Effect of material selection and design on the environmental impact*

in the manufacturing process Explores how material selection and product design influence the environmental impact of manufacturing processes.

3. **Book**: *Sustainable Materials and Manufacturing Technologies* Discusses challenges in processing advanced materials and strategies to achieve sustainability in manufacturing technologies.
4. **Journal article:** *Selection of sustainable material for the manufacturing of complex automotive products using a new hybrid Goal Programming Model for Best Worst Method–Proximity Indexed Value method* Examines methodologies for selecting suitable sustainable materials to meet specific product requirements in manufacturing.
5. **Book chapter with case studies:** *Materials Development for Sustainable Manufacturing* Analyzes case studies demonstrating the benefits of understanding material properties for process optimization in sustainable manufacturing.

04S: DESIGN. Skills to design with a sustainable approach.

1. **Journal Article:** *Strategies for developing sustainable design practice for students and SME professionals.* Examples of teaching and learning methods to support sustainable design practices.
2. **Conference paper:** *Learning resources For Sustainable Design in Engineering Education.* Paper introduces an Open Educational Resources database (http://circulardesigneurope.eu/oer/) comprised of various Circular design resources.
3. **Case studies:** *Energy efficient and sustainable design solutions for the built environment.*

07S: POLLUTION. Skills to use pollution prevention strategies.

1. **EU Strategy**: *Zero Pollution Action Plan.* EUs strategy to reduce pollution across air, water, and soil, aiming for a cleaner, healthier environment by 2050.
2. **Journal article:** *Research on strategies of air pollution prevention and control in civil Engineering projects*. Paper presents pollution prevention and control strategies for civil engineering projects.
3. **Blog post**: *How air quality engineers help with air pollution control.*

08S: WASTE. Skills to implement waste management for sustainability.

1. **Case studies / resources**: *Zero Waste Europe Library*. Guidance and case studies to support a zero waste society and future.
2. **Journal article:** *Educating Engineers for the Circular Economy.* Provides examples of how the Circular Economy is taught in selected engineering courses in the UK.
3. **Journal article:** *Waste Management and Sustainability during the Design Phase of a Construction Project: A Qualitative Review.* Paper highlights the importance of integrating waste management strategies at the design phase of construction projects.

11S: CONSTRUCTION. Skills to promote sustainable construction.

1. **Case studies**: *The Alliance for Sustainable Building Products (ASBP) - Case Studies of Sustainable Buildings and Materials.* A collection of case studies from the UK Alliance for Sustainable Building Products, featuring examples building materials and practices with high sustainability credentials.
2. **Teaching tools**: *Engineering Professors Council Sustainability Toolkit.* Includes Activities, Case studies, Project materials, and Assessment and Accreditation materials.
3. **EU Policy Brief:** *EU Construction & Demolition Waste Protocol.* EU guidelines on Construction and Demolition Waste Management.

12S: RISK ASSESSMENT. Skills to give importance to risk assessment for sustainability (06K)

1. **Conference paper:** *Sustainability Risk Management: The Case for Using Interactive Methodologies for Teaching, Training and Practice in Environmental Engineering and Other Fields.* Paper highlights the need for sustainability risk management (SRM) as a critical skill for engineers and promotes interactive techniques to build risk assessment capabilities.
2. **Journal article:** *Sustainability risk assessment in mega construction projects.* Paper presents a novel risk assessment method for mega construction projects.
3. **Masters thesis**: *Risk Management in Sustainable Projects in the Construction Industry.* Case studies of Swedish companies experience of assessing and managing risks faced in green building construction.

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0K1: BACKGROUND. The evolution of sustainability and the SDGs

1. **UN Report**: *Our Common Future (the Brundtland Report).* UN Report that laid the foundation for the SDGs.
2. **UN Agenda**: *Transforming our World: the 2030 Agenda for Sustainable Development*. The UN's blueprint, adopted in 2015, that set out the 17 Sustainable Development Goals (SDGs).
3. **Journal article:** *Evolution of the concept of sustainability. From Brundtland Report to sustainable development goals.* Paper explores the emergence and evolution of the concept of sustainable development.

05K: THREATS. Principal environmental threats & how they are measured

1. **Journal article:** *A safe operating space for humanity.* Presents the planetary boundary framework, which identifies nine critical Earth system processes that must stay within safe limits to prevent catastrophic environmental change. Framework links principal environmental threats like climate change and biodiversity loss to scientifically measurable thresholds.
2. **Journal article:** *The 2023 state of the climate report: Entering uncharted territory.* Presents trends in planetary vital signs.
3. **OER**: *Using Student Perceptions and Cooperative Learning to Unpack Primary Literature on Global Change.* Presents a three-part assignment which aims to teach students about earth systems processes in an ecological context and to have students effectively communicate their perceptions of environmental change to their peers.
4. **Blog article**: *Environmental risks: what they are, types and management.* Article describes different types of

environmental risks and strategies for prevention and mitigation.

06K: RISK. Risk Assessment for Sustainability (12S)

1. **Conference paper:** *Sustainability Risk Management: The Case for Using Interactive Methodologies for Teaching, Training and Practice in Environmental Engineering and Other Fields.* Paper highlights the need for sustainability risk management (SRM) as a critical skill for engineers and promotes interactive techniques to build risk assessment capabilities.
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07K: SOCIETY. Sustainability and social systems

1. **Journal article:** *A strategic approach to social sustainability – Part 1: exploring the social system.* Presents a systems-based approach to social sustainability.
2. **Report by the EC (chapter 6)**: *Sustainability and governance: the role of social dialogue.* Explores the role of social dialogue in achieving the SDGs.
3. **Case study**: *Systems Thinking case study — Social impact of the 'green' transition.* Article describes the author's experience of a free online course *Designing for Environmental Sustainability and Social Impact*, and presents a case study on the Sami community of Sweden and their experience struggling to preserve their cultural heritage and traditional way of life from the expansion of mining industries.

08K: ENVIRONMENTAL. Sustainability and the environment (02S)

1. **Review paper**: *From environmental education to education for sustainable development in higher education: a systematic review.* Paper includes case studies in engineering where education for sustainable development has been incorporated.
2. **Teaching tools**: *Engineering Professors Council Sustainability Toolkit.* Includes Activities, Case studies, Project materials, and Assessment and Accreditation materials.
3. **Book chapter**: Sustainability in Engineering Education. Experiences of Educational Innovation. Presents and analyses successful learning experiences, problems and difficulties, and testimonials from students and professors from Universidad Politécnica de Madrid, complemented by other published cases.

15K: MATERIAL. Material classification from an environmental perspective (recyclable, renewable, bio-based)

1. **Case studies**: *The Alliance for Sustainable Building Products (ASBP) - Case Studies of Sustainable Buildings and Materials.* A collection of case studies from the UK Alliance for Sustainable Building Products, featuring examples building materials and practices with high sustainability credentials.
2. **Journal article:** *Circular bio-based building materials: A literature review of case studies and sustainability assessment methods.* Paper presents a systematic review of literature describing circular bio-based building materials.
3. **Various resources (articles, videos etc.):** *International Council for Circular Economy Resources.* Various resources that can be integrated into OER modules.

17K: CIRCULARITY. Circular supply chain & sustainable resource management (06S)

1. **Journal article:** *Towards the implementation of Circular Economy in Engineering Education: A systematic review* Reviews and summarizes the research work and some implementation initiatives on Circular Economy in learning activities for engineering students.
2. **Journal article:** *Integrating circular economy into STEM education: A promising pathway toward circular citizenship development*

3. **EU Strategy:** *Circular Economy Action Plan* An essential reference policy document providing a roadmap for circularity in product lifecycles and resource flows.

Source: **Various resources, including real world case studies and teaching resources:** (1) *Ellen MacArthur Foundation* *(2) Higher Education Resources*

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