Postgraduate Certificate in Climate Risk Analysis

Climate Change Mitigation

Afforestation
Related terms: reforestation, carbon sink, land-use change
A deliberate process of establishing forest cover on lands that historically have not contained forests. It captures atmospheric CO_2 through tree growth, creating a biological carbon store. Practical application includes planting native species on degraded agricultural fields. Challenges involve long-term land tenure security, water availability, and ensuring biodiversity benefits rather than monocultures.

Carbon Capture, Utilisation and Storage (CCUS)
Related terms: carbon capture, sequestration, negative emissions
A suite of technologies that capture CO_2 from point sources or the atmosphere, convert it into useful products or inject it into geological formations for long-term storage. Example projects include CO_2-enhanced oil recovery and mineral carbonation. Major challenges are high capital costs, energy penalties, and public acceptance of underground storage sites.

Carbon Pricing
Related terms: carbon tax, emissions trading system, market-based mechanisms
An economic tool that assigns a cost to each tonne of CO_2 emitted, incentivising emitters to reduce emissions where it is cheapest to do so. Implemented via a direct tax on fossil fuel combustion or a cap-and-trade scheme. Practical application includes revenue recycling for renewable energy subsidies. Challenges include setting an appropriate price level, avoiding carbon leakage, and political resistance.

Carbon Neutrality
Related terms: net-zero, carbon offset, climate neutrality
A state where the net amount of CO_2 emitted into the atmosphere is zero, achieved by balancing emitted CO_2 with an equivalent amount removed or avoided. Companies may purchase verified carbon offsets to compensate for residual emissions after internal reductions. The main challenge lies in ensuring the integrity and permanence of offset projects and avoiding “green-washing”.

Carbon Offsetting
Related terms: offset projects, verification standards, additionality
The practice of compensating for emissions by funding external activities that reduce or sequester CO_2, such as renewable energy installations or forest conservation. Effective offsets must be additional, measurable, and permanent. Practical use includes travel-related offsetting for conference attendees. Challenges involve verifying real climate benefit, avoiding double counting, and ensuring social equity in host communities.

Carbon Pricing
Related terms: carbon tax, emissions trading system, market-based mechanisms
An economic instrument that imposes a cost on each tonne of CO_2 emitted, guiding emitters towards lower-cost abatement options. Implemented either as a direct tax on fossil fuel use or as a cap-and-trade system where allowances are auctioned. Practical outcomes include revenue for climate-resilient infrastructure. Challenges encompass setting an optimal price, preventing carbon leakage, and achieving political consensus.

Carbon Sequestration
Related terms: biological sequestration, geological storage, carbon sinks
The long-term removal and storage of CO_2 from the atmosphere in physical reservoirs such as forests, soils, or deep-rock formations. Forests sequester carbon through photosynthesis, while soils retain organic carbon via microbial processes. Geological sequestration involves injecting compressed CO_2 into depleted oil and gas reservoirs. Challenges include permanence, monitoring, and potential leakage.

Carbon Tax
Related terms: price on carbon, fiscal instrument, emissions levy
A direct tax levied on the carbon content of fossil fuels, translating the social cost of emissions into market prices. It provides a clear price signal that encourages energy efficiency and low-carbon technology adoption. Countries like Sweden have demonstrated high tax rates with significant emission reductions. Implementation challenges involve setting tax rates that balance economic impact and climate ambition, and addressing regressive effects on low-income households.

Decarbonisation
Related terms: decarbonisation pathway, low-carbon transition, emissions reduction
The systematic reduction of carbon intensity in energy production, industrial processes, and transportation, ultimately aiming for minimal or zero CO_2 emissions. Strategies include shifting to renewable electricity, electrifying transport, and adopting energy-efficient processes. Practical application is illustrated by the EU's Power System Transformation. Challenges involve technology readiness, grid integration, and financing large-scale infrastructure upgrades.

Direct Air Capture (DAC)
Related terms: negative emissions, CO_2 removal, carbon engineering
A set of technologies that extract CO_2 directly from ambient air using chemical sorbents or filters, then concentrate and store or utilise the captured CO_2. Pilot plants in the United States and Iceland demonstrate scalability. The main challenges are high energy demand, cost per tonne of CO_2 removed, and the need for low-carbon electricity to power the process.

Energy Efficiency
Related terms: energy conservation, demand-side management, efficiency standards

Measures that achieve the same service or output with less energy input, thereby reducing emissions and operating costs. Examples include high-efficiency LED lighting, building envelope retrofits, and industrial heat-recovery systems. While cost-effective, barriers include split incentives, upfront capital constraints, and insufficient information on performance gains.

Energy Transition
Related terms: decarbonisation, renewable integration, sector coupling
The overarching shift from fossil-based energy systems to low-carbon or carbon-neutral configurations, encompassing generation, distribution, and consumption. It involves expanding renewable generation, modernising grids, and deploying storage technologies. Practical illustration: Germany's "Energiewende". Challenges include maintaining system reliability, managing intermittency, and addressing workforce displacement in traditional energy sectors.

Emission Trading System (ETS)
Related terms: cap-and-trade, allowance, market-based mitigation
A regulatory framework that caps total emissions and allocates tradable permits to emitters. Participants can buy or sell allowances, creating a market price for emissions. The EU ETS is the largest example, covering power, industry, and aviation. Challenges involve overall cap stringency, allowance allocation methods, and preventing market manipulation.

Feedstock Substitution
Related terms: material efficiency, bio-based feedstocks, circular economy
Replacing carbon-intensive raw materials (e.g., fossil-based plastics) with lower-carbon alternatives such as bio-based polymers or recycled content. This reduces embodied emissions in product lifecycles. Example: using bio-derived polyethylene in packaging. Barriers include supply chain scalability, performance parity, and certification of sustainability credentials.

Green Hydrogen
Related terms: electrolysis, renewable energy, low-carbon fuel
Hydrogen produced by electrolysing water using electricity sourced from renewables, resulting in near-zero CO_2 emissions. Used as a clean fuel for hard-to-decarbonise sectors like heavy industry and shipping. Projects such as the "HyDeploy" trial in the UK illustrate early deployment. Main challenges are high electrolyser costs, water resource management, and establishing transport infrastructure.

Industrial Decarbonisation
Related terms: process electrification, carbon capture, low-carbon fuels
Targeted reduction of emissions from heavy industry (steel, cement, chemicals) through technology upgrades, fuel switching, and CCUS. For instance, using electric arc furnaces in steelmaking reduces reliance on coal. Challenges include retrofitting existing plants, high capital intensity, and ensuring product quality is maintained.

Land-Use Change
Related terms: deforestation, reforestation, carbon accounting
Alterations in how land is managed, which can either release stored carbon (e.g., forest clearing) or sequester it (e.g., afforestation). Accurate accounting is essential for national mitigation pledges. Practical tools include remote sensing and GIS mapping. Challenges involve balancing food security, biodiversity, and carbon goals.

Low-Carbon Technology
Related terms: clean tech, renewable energy, climate-friendly solutions
Any technology that emits substantially less CO_2 compared with conventional alternatives. Examples encompass wind turbines, solar photovoltaics, and advanced battery storage. Adoption is driven by cost reductions, policy incentives, and corporate sustainability targets. Barriers include technology maturity gaps, supply chain constraints, and financing for early-stage innovations.

Negative Emissions
Related terms: carbon removal, net-negative, climate mitigation
Processes that actively remove CO_2 from the atmosphere, resulting in a net reduction of atmospheric carbon. Approaches include afforestation, BECCS (bio-energy with carbon capture and storage), and DAC. While essential for meeting 1.5 °C pathways, challenges involve scalability, land competition, and ensuring permanence.

Renewable Energy
Related terms: solar, wind, hydro, low-carbon power
Electricity generated from naturally replenishing sources that emit little or no CO_2 during operation. Solar photovoltaics and onshore wind have become cost-competitive with fossil generation. Integration challenges include intermittency, grid stability, and the need for storage or demand-response solutions.

Renewable Energy Certificates (RECs)
Related terms: green tags, provenance tracking, market mechanisms
Tradable instruments that verify that a certain amount of renewable electricity has been generated and fed into the grid. Organizations purchase RECs to claim renewable sourcing for their electricity consumption. Challenges include ensuring additionality, avoiding double counting, and maintaining transparent tracking systems.

Resilience-Focused Mitigation
Related terms: adaptation-mitigation synergy, climate-smart, robust pathways
Strategies that simultaneously reduce emissions and enhance system resilience to climate impacts. For example, decentralised microgrids powered by solar reduce emissions while providing reliable power during extreme weather. Challenges lie in integrated planning, financing dual-benefit projects, and aligning policy objectives across sectors.

Sector Coupling
Related terms: energy integration, electrification, cross-sector synergies
Linking traditionally separate energy sectors (power, heat, transport, industry) to optimise overall system efficiency and enable deeper decarbonisation. An example is using excess renewable electricity for electric vehicle charging or for power-to-heat in district heating networks. Barriers include regulatory fragmentation, market design, and technical interoperability.

Smart Grids
Related terms: digitalisation, demand response, grid flexibility
Modernised electricity networks that incorporate information technology, sensors, and automated controls to balance supply and demand in real time. Smart meters enable dynamic pricing, encouraging consumers to shift load to periods of high renewable generation. Key challenges are cybersecurity, data privacy, and ensuring equitable access to advanced grid services.

Solar Photovoltaics (PV)
Related terms: solar power, module efficiency, distributed generation
Technology that converts sunlight directly into electricity using semiconductor materials. PV installations range from rooftop systems to utility-scale farms. Declining module costs have accelerated adoption worldwide. Challenges include land use for large farms, recycling of end-of-life panels, and variability requiring storage or grid integration solutions.

Supply Chain Decarbonisation
Related terms: Scope 3 emissions, carbon accounting, low-carbon procurement
Reducing greenhouse-gas emissions across the full lifecycle of products, from raw material extraction to end-of-life disposal. Companies often engage suppliers in emissions reporting and set science-based targets. Practical tools include Life-Cycle Assessment (LCA) and carbon-footprint calculators. Obstacles include data availability, supplier engagement, and the complexity of multi-tiered supply chains.

Sustainable Aviation Fuel (SAF)
Related terms: bio-fuel, low-carbon jet fuel, aviation decarbonisation
A drop-in replacement for conventional jet fuel derived from renewable feedstocks such as waste oils, agricultural residues, or captured CO_2 combined with hydrogen. SAF can reduce lifecycle CO_2 emissions by up to 80 % compared with fossil jet fuel. Barriers include limited production capacity, high cost, and certification processes for new feedstocks.

Technology Readiness Level (TRL)
Related terms: innovation pipeline, maturity assessment, risk management
A nine-point scale used to assess the maturity of a technology, from basic principles (TRL 1) to fully commercialised systems (TRL 9). It helps investors and policymakers prioritise funding. For mitigation, many low-carbon technologies are still at intermediate TRLs, requiring risk-mitigation strategies and pilot

demonstrations.

Thermal Energy Storage
Related terms: heat storage, molten salt, district heating
Systems that store heat for later use, enabling better integration of renewable electricity in heating applications. Molten-salt storage is common in concentrated solar power plants, while seasonal storage can be achieved with underground aquifers. Challenges include material degradation, thermal losses, and high upfront capital costs.

Transitional Finance
Related terms: green bonds, sustainable investment, climate-aligned capital
Funding directed toward projects that reduce emissions in the short-to-medium term while paving the way for deeper decarbonisation. Examples include financing natural-gas plants with carbon capture or retrofitting coal-fired plants with efficiency upgrades. Critics argue that such finance may delay full transition if not coupled with clear phase-out pathways.

Vertical Farming
Related terms: controlled environment agriculture, indoor cultivation, resource efficiency
A method of growing crops in stacked layers within controlled indoor environments, often powered by LED lighting and renewable electricity. It reduces land use and can lower emissions associated with transportation. However, high energy demand for lighting and climate control can offset benefits unless powered by clean energy sources.

Water-Energy-Food Nexus
Related terms: integrated resource management, systemic risk, co-benefits
The interdependent relationship among water, energy, and food systems, where actions in one domain affect the others. For mitigation, shifting to renewable electricity can reduce water-intensive thermal power generation, while efficient irrigation reduces energy demand. Managing trade-offs requires cross-sectoral governance and scenario analysis.

Zero-Emission Vehicles (ZEVs)
Related terms: electric vehicles, fuel-cell vehicles, low-carbon transport
Vehicles that emit no tailpipe CO_2, powered either by electricity stored in batteries or by hydrogen fuel cells. Adoption is accelerated by subsidies, charging infrastructure roll-out, and corporate fleet commitments. Challenges remain in battery material supply chains, recycling, and ensuring electricity used for charging is low-carbon.

Carbon Budget
Related terms: emissions pathway, cumulative emissions, climate targets
The total amount of CO_2 that can be emitted globally while limiting temperature rise to a specific threshold (e.g., 1.5 °C). The Intergovernmental Panel on Climate Change (IPCC) provides quantitative budgets. Nations

use these to set national mitigation pathways. Main challenges include equitable allocation, accounting for non-CO_2 gases, and translating global budgets into sector-specific targets.

Climate-Smart Agriculture
Related terms: agroforestry, sustainable intensification, soil carbon
Farming practices that simultaneously increase productivity, enhance resilience, and reduce greenhouse-gas emissions. Techniques include conservation tillage, precision fertiliser application, and integrating trees on farms. Practical examples are the “4 per 1000” initiative aiming to increase soil carbon by 0.4 % per year. Barriers include farmer knowledge gaps, upfront costs, and market access for low-carbon produce.

Distributed Generation
Related terms: behind-the-meter, micro-generation, grid decentralisation
Small-scale electricity production located close to the point of consumption, often using solar PV, wind turbines, or combined heat and power (CHP) systems. It reduces transmission losses and can provide resilience during grid outages. Integration challenges involve voltage regulation, net-metering policies, and ensuring fair compensation for producers.

Energy Storage
Related terms: batteries, pumped hydro, grid flexibility
Technologies that store energy for later use, smoothing the mismatch between variable renewable generation and demand. Lithium-ion batteries dominate short-term storage, while pumped hydro provides bulk, long-duration capacity. Emerging options include flow batteries and hydrogen-based storage. Key challenges are cost decline, material sustainability, and regulatory frameworks for storage participation in energy markets.

Emission Factor
Related terms: CO_2 intensity, carbon accounting, life-cycle assessment
A coefficient that quantifies the amount of CO_2 emitted per unit of activity, such as kg CO_2 per kWh of electricity generated. Emission factors are essential for calculating organisational carbon footprints. Accuracy depends on data granularity, fuel mix, and technology efficiency. Updating factors regularly is necessary to reflect grid decarbonisation progress.

Green Building
Related terms: LEED, BREEAM, energy-efficient design
Construction and operation of buildings that minimise environmental impact through energy efficiency, renewable energy integration, sustainable materials, and indoor environmental quality. Certifications like LEED provide performance benchmarks. Practical measures include high-performance insulation, smart HVAC controls, and daylighting design. Barriers include higher upfront costs, limited skilled labour, and regulatory approval processes.

Integrated Assessment Model (IAM)

Related terms: scenario analysis, climate-economy modelling, policy evaluation
Computational frameworks that combine climate science, economics, and technology data to assess the impacts of mitigation pathways. Examples include the MESSAGE-IAM and DICE models. They inform policymakers on cost-effectiveness of different strategies. Limitations involve uncertainties in socioeconomic assumptions, parameter sensitivity, and the representation of non-CO_2 gases.

Life-Cycle Assessment (LCA)
Related terms: cradle-to-grave, carbon footprint, product stewardship
A systematic method for evaluating the environmental impacts of a product or service throughout its entire life—from raw material extraction to disposal. LCA quantifies embodied emissions, enabling identification of high-impact stages for targeted mitigation. Challenges include data availability, methodological consistency, and incorporating indirect emissions such as supply-chain logistics.

Low-Carbon Economy
Related terms: decarbonisation, green growth, sustainable development
An economic system where the majority of activities emit minimal CO_2, achieved through renewable energy, energy efficiency, and structural shifts in industry and consumption. Transition policies include carbon pricing, green public procurement, and innovation funding. Obstacles involve entrenched fossil-fuel interests, workforce transition, and ensuring social equity during the shift.

Marginal Abatement Cost (MAC)
Related terms: cost-effectiveness, emissions reduction, policy design
The incremental cost of reducing an additional tonne of CO_2 using a specific mitigation option. MAC curves help rank measures from most to least cost-effective. They are used by governments to design incentive schemes and by corporations to prioritise investments. Accuracy depends on reliable cost data, technology performance, and assumptions about future energy prices.

Net-Zero Emissions
Related terms: carbon neutrality, climate-neutral, balance-sheet emissions
A state where all anthropogenic CO_2 emissions are balanced by removals, resulting in no net increase in atmospheric CO_2. Achieving net-zero typically requires deep emissions cuts across all sectors combined with carbon removal technologies or nature-based solutions. Corporate net-zero pledges must align with science-based targets and transparent accounting to avoid “green-washing”.

Nature-Based Solutions (NBS)
Related terms: ecosystem restoration, carbon sequestration, biodiversity co-benefits
Interventions that protect, sustainably manage, or restore natural ecosystems to address climate change while delivering additional ecological and social benefits. Examples include restoring mangroves for coastal protection and carbon storage, and implementing agroforestry. Challenges involve ensuring permanence, measuring outcomes, and balancing land-use competition with food production.

Power-to-X (P2X)
Related terms: electro-fuels, hydrogen, synthetic methane
A suite of technologies that convert surplus renewable electricity into other energy carriers such as hydrogen, ammonia, or liquid fuels via electrolysis and subsequent synthesis. P2X enables sector coupling and storage of renewable energy in chemical form. Practical projects include the “Hywind” offshore wind-hydrogen hub. Barriers are conversion efficiency losses, high capital costs, and the need for end-use markets.

Renewable Portfolio Standard (RPS)
Related terms: renewable mandate, clean energy target, policy instrument
A regulatory requirement that utilities obtain a specified percentage of electricity from renewable sources by a target date. RPS policies have driven renewable deployment in several U.S. states. Implementation challenges include defining eligible technologies, ensuring cost-effectiveness, and avoiding unintended spikes in electricity prices.

Scope 1, 2, 3 Emissions
Related terms: carbon accounting, corporate footprint, value-chain emissions
Classification of greenhouse-gas emissions: Scope 1 (direct emissions from owned sources), Scope 2 (indirect emissions from purchased electricity, heat, or steam), and Scope 3 (all other indirect emissions across the value chain, such as product use and waste). Comprehensive mitigation strategies address all three scopes, though Scope 3 data collection is often most challenging.

Sectoral Decarbonisation
Related terms: industry pathways, sector-specific targets, technology roadmaps
Tailored strategies to reduce emissions within a specific economic sector, such as transport, power, or agriculture. Sectoral pathways consider unique technical constraints, policy levers, and market dynamics. For example, the aviation sector focuses on SAF and electric propulsion for short-haul flights. Coordination across sectors is required to avoid carbon leakage and ensure system-wide efficiency.

Smart Metering
Related terms: advanced metering infrastructure, demand response, data analytics
Digital devices that record electricity consumption in near real-time and communicate data to utilities and consumers. Enables time-of-use tariffs that encourage shifting demand to periods of high renewable generation. Implementation challenges include privacy concerns, installation costs, and ensuring that tariff structures actually influence consumer behaviour.

Sustainable Development Goals (SDGs)
Related terms: UN agenda, climate action, integrated policy
A set of 17 global goals adopted by United Nations member states, with Goal 13 explicitly addressing climate action. Mitigation efforts intersect with other goals such as clean water (SDG 6) and affordable clean

energy (SDG 7). Aligning mitigation projects with multiple SDGs can attract broader financing but requires careful assessment of trade-offs.

Technology Transfer
Related terms: knowledge diffusion, capacity building, licensing
The process of moving low-carbon technologies from research institutions or developed markets to emerging economies for deployment. Mechanisms include joint ventures, public-private partnerships, and international climate finance. Barriers include intellectual-property rights, lack of local technical expertise, and differing regulatory environments.

Thermal Decarbonisation
Related terms: heat pumps, district heating, low-carbon heating
Reducing CO_2 emissions from space heating, industrial process heat, and water heating. Strategies include electrifying heat via heat pumps, integrating renewable-based district heating networks, and using biomass with carbon capture. Challenges involve retrofitting existing building stock, high upfront costs, and ensuring that electricity supply is decarbonised.

Urban Heat Island Mitigation
Related terms: cool roofs, green infrastructure, climate-resilient cities
Measures that reduce elevated temperatures in urban areas, which can lower energy demand for cooling and improve health outcomes. Approaches include reflective roofing materials, expanding urban tree canopy, and installing cool pavements. While primarily an adaptation measure, these actions also contribute to mitigation by decreasing electricity consumption.

Variable Renewable Energy (VRE)
Related terms: intermittent generation, wind, solar PV
Renewable electricity sources whose output fluctuates with weather conditions and time of day, such as wind turbines and solar panels. Integration of VRE requires flexible generation, storage, and demand-side management to maintain grid stability. Challenges include forecasting accuracy, transmission constraints, and market mechanisms that reward flexibility.

Zero-Carbon Buildings
Related terms: net-zero energy, passive house, carbon-free construction
Buildings that operate without emitting any net CO_2 over a defined period, typically achieved through a combination of high energy efficiency, on-site renewable generation, and, where necessary, carbon offsets. Certification schemes like the Zero Carbon Hub provide benchmarks. Barriers include higher design complexity, need for integrated planning, and ensuring occupant behaviour aligns with performance goals.