Circular Activity Sheets

Guidance on Increasing NDC Ambitions through Circular Action

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Contents

Explanation Sheet	
CE category	Circular Economy Category according to Guidance on Strengthening NDC Ambitions through Circular Action (CE NDC Guidance) section 1.2
Product group	Product group(s) according to CE NDC Guidance section section 1.2 (box 1-1)
Context	Background, facts and figures and description of the activity and its GHG emission mitigation or climate adaptation effect
Instruments for implementation	Approaches and instruments for implementing the activity at national, regional and/or local levels. Most of the proposed activities could also be done at other government levels than indicated depending on country structures and responsibilities.
Potential Climate adaptation or GHG mitigation impact	Potential of the activity to enhance climate resilience (in sheets focusing on GHG mitigation) or avoid/reduce GHG emissions (in sheets focusing on adaptation to climate change) as a secondary target or co-benefit.
Co-benefits	Potential co-benefits of the activity beyond climate impacts, for instance on environmental protection or socioeconomic development
Potential indicators	Suggested indicators for monitoring the activity implementation
Assumptions and preconditions	Assumptions and preconditions necessary for the successful implementation of the activity
Time schedule	Estimated time range for the activity to take effect, in most cases only indicating the most time intense processes: Short term: 1-3 years, medium: 3-5 years, long: more than 5 years
Proposed steps to determine GHG emission impacts and Emission Factors (only in GHG mitigation sheets)	Proposed simplified steps and/or formula to estimate the effect of the activity on GHG emissions or reference to sample emission factor from the IPCC emission factor database The suggested approach gives a first impression on calculating the GHG mitigation effect but does not cover all potential effects. Further analysis and expert advice are needed if the activity is chosen for climate reporting.
IPCC Guidelines volumes, chapters, and worksheets (only in GHG mitigation sheets)	Reference to specific volumes, chapters, worksheets and/or source categories of the IPCC Guidelines for National Greenhouse Gas Inventories (version 2006) Alphanumeric codes (such as 2A1) refer to IPCC 2006 source categories and worksheets, if indicated
Description of Climate Risk (only in adaptation sheets)	Description of a climate risk context which would justify the activity, consisting of hazard, exposure and vulnerability as described in the IPCC AR6 climate risk framework.
Data needs	Data needed at the national (and sub-national) level to monitor and report on activity implementation
Further guidance, research, and tools	Reference to existing tools, methodologies, research and/or projects on the activity
Covered in NDCs	Reference to country NDCs, which refer to that or a similar activity

Disclaimer

The sheets describe Circular Economy activities and their impacts on the mitigation of greenhouse gas (GHG) emissions and adaptation to the impacts of climate change, covering several sectors. All sheets are one-pagers, providing a broad overview and introduction into a circular activity and mostly focusing on one specific climate impact.

Before considering the implementation of individual activities, these need to be analysed in more detail and adapted to the specific national and potentially sub-national context. The feasibility to implement each activity and its integration into national climate planning processes depends on several criteria including institutional, technical, social, financial and other aspects and needs to be further investigated in each case. The suggested steps to estimate GHG emissions mitigation and climate risk impacts provide an initial rough concept to build on. It is recommended to apply internationally recognized guidelines and methodologies. It should be noted that mitigation of GHG emissions included in the activity sheets can only be reported if these happen domestically.

Please contact us at gocircular@giz.de in case something seems wrong or misleading.

AFN1: Food Loss Reduction	
CE category	1 Increase material efficiency in production and other processes along the lifecycle
Product group	Food and feed products
Context	Food losses refer to food lost at the production, post-harvest, processing and transportation stages of the food chain before the retail level. It is estimated that 13% of global food produced is lost between harvest and retail. Food losses can generate GHG emissions, for instance methane (CH_4) if landfilled. Reduction of food losses can avoid CH_4 emissions from landfills and improper organic waste treatment. In addition, as food is produced more efficiently, reducing food losses can prevent the conversion of land into agricultural soils and respective GHG emissions. Increased food production efficiency also translates into a more efficient use of energy, water and other resources and their emissions.
Instruments for implementation	National: National food loss and waste reduction strategies and policies, incentives for sustainable practices, investment in infrastructure and research Local: Community engagement and capacity development involving farmers and food producers, introduction of several methods, including e.g. improved grain storage, climate friendly (low GHG) storage and transport cooling, food processing technologies, enhancing capacities on post-harvest management and data collection etc.
Potential Climate adaptation or GHG mitigation impact	Reduced food losses can decrease food insecurity caused by impacts of climate change such as intense precipitation and drought events threatening crop development and revenue loss in agriculture and therefore reduce climate change induced vulnerability.
Co-benefits	Improved agricultural productivity and food security Improved land use efficiency, protecting forests and natural carbon sinks Improved water use efficiency, protecting available freshwater resources
Potential indicators	Yield gap: Difference between potential and actual yield Food losses before retail including production, post-harvest, processing and transportation stages
Assumptions and preconditions	Improved agricultural productivity prevents the need to expand cultivation. GHG-intense cooling technologies are avoided. Capacity building is available for farmers and processors.
Time schedule	Medium to long: several agricultural cycles are needed to sustainably reduce food losses.
Proposed steps to determine GHG emission impacts and Emission Factors	1. Collect data on amount of food lost 2. Estimate GHG emissions from food losses using e.g. FAO approach (Emissions = activity data * emission factor) 3. Apply food loss GHG emission reduction figures according to measures taken 4. Add emissions from food loss prevention strategies if applicable 5. Calculate the amount of mitigated GHG emissions These steps do not cover GHG emission reductions from avoided land use change.
IPCC Guidelines volumes, chapters, and worksheets	Volume 3: IPPU: worksheet 2H2 Food and Beverages Industry Volume 4: Agriculture, Forestry and Other Land Use: Worksheets: 3B1a Forest Land Remaining Forest Land, 3B3a Grassland Remaining Grassland, 3B4a Wetlands Remaining Wetlands, 3C4 Direct N_2O Emissions from Managed Soils Volume 5: Waste: Chapters 3 Solid Waste Disposal, Chapter 4 Biological Treatment of Solid Waste, and Chapter 5 Incineration and Open Burning of Waste
Data needs	Amount and GHG emissions from food losses e.g. disposed of, burnt or composted GHG emissions from agricultural processes including energy use secondary data of potential relevance including emissions from supply-chain activities, Life-Cycle Analysis data
Further guidance, research, and tools	EX-Ante Carbon-balance Tool (EX-ACT) FAO Food Loss App (FLAPP) IFC's Food Loss Climate Impact Tool The Cool Farm Tool UNEP, UNDP and UNFCCC secretariat (2023): Building Circularity into Nationally Determined Contributions (NDCs): Section on Food Loss and Waste in Chapter 4
Covered in NDCs	Gambia, Uruguay, and others

AFN2: Food Waste Reduction	
CE category	1 Increase material efficiency in production and other processes along the lifecycle
Product group	Food and feed products
Context	About 17% of total global food production is wasted during retail, services and in households, referred to as food waste. Its reduction can avoid GHG emissions resulting from open dumping, landfilling and improper operations of composting and biogas facilities.
Instruments and measures for implementation	National level: Changes in regulations preventing food waste; policies providing enabling framework conditions, e.g. incentives for businesses, which reduce food waste and allow the distribution of excess food Regional and municipal level: Initiatives like food rescue programs; awareness and knowledge campaigns targeted to regional/local businesses (e.g. restaurants) and citizens, awareness campaigns for businesses and households on reducing excessive food purchases and food conservation practices
Potential Climate adaptation impact	Less food waste through increased food use efficiency could decrease the vulnerability of communities to climate hazards affecting food security like droughts or floods.
Co-benefits	Improved food security: SDG target 12.3 aims at halving food waste. Conservation of energy, water and land resources, which are used more efficiently Reduced consumer spending for food Reduced amount of total waste to be processed
Potential indicators	Total food waste generated (in weight or volume of food wasted across different stages: retail and consumption) Food waste per capita → see also UNEP Food Waste Index Report 2024 on food waste measurement methodology Food losses before retail including production, post-harvest, processing and transportation stages
Assumptions and preconditions	Public awareness and readiness to change behaviour are developed, for instance through conservation practices and moderation in food purchases.
Time schedule	Long: Behavioural change of society towards adopting food waste reduction practices is expected to take long
Proposed steps to determine GHG emission impacts and Emission Factors	For avoided GHG emissions from waste disposal and treatment: 1. Collect data on amount of food wasted 2. Estimate GHG emissions from food waste using e.g. FAO approach (Emissions = activity data * emission factor) 3. Apply food waste GHG emission reduction figures according to measures taken 4. Add emissions from food waste prevention strategies if applicable 5. Calculate the amount of mitigated GHG emissions
IPCC Guidelines volumes, chapters, and worksheets	Volume 5: Waste: Chapters 3 Solid Waste Disposal, Chapter 4 Biological Treatment of Solid Waste, and Chapter 5 Incineration and Open Burning of Waste For emission mitigation from reduced food production (food and beverage industry and avoided land use change), see previous sheet
Data needs	Current amount of total food waste generated, waste generated per capita and consumption of food streams per capita; Amount/share of food waste landfilled and of food waste composted Secondary data of potential relevance include emissions from supply-chain activities, Life-Cycle Analysis data
Further guidance, research, and tools	FAO Food Loss and Waste Database UNEP Food Waste Index Report 2024 UNEP, UNDP and UNFCCC secretariat (2023): Building Circularity into Nationally Determined Contributions (NDCs): Section on Food Loss and Waste in Chapter 4 GIZ Solid Waste Management Calculator for estimating GHG emissions from food waste Porter et a. (2015): Addressing food supply chain and consumption inefficiencies: potential for climate change mitigation. In: Regional Environmental Change. 16
Covered in NDCs	Andorra (referring to Circular Economy Strategy), China (referring to Empty Plate Campaign)

AFN3: Transition to a Plant-Based Diet	
CE category	5.1 Substitute a technical solution by a more material-efficient one
Product group	Food and feed products
Context	The consumption of meat as food is a major cause of GHG emissions, as livestock animals and manure emit large amounts of methane. Estimates suggest that switching to a plant-based diet can cut a person's annual carbon footprint by approximately up to 1.9 tonnes of CO_2eq for vegans or 1.4 tonnes for vegetarians. In comparison to a plant-based diet, a meat-based diet requires a 2-10 times larger land size for the same food energy content, including for producing animal feed. This also results in reduced need for cropland causing e.g. deforestation.
Instruments and products for implementation	National: Policy framework development supporting the switch to plant cultivation All levels: Information and awareness campaigns on increasing plant-based share of diet (justification, advice on sourcing of vegetables etc.); limit subsidies for animal farming for land not available for crop cultivation and intensive livestock farming while introducing incentives for plant cultivation
Potential Climate adaptation impact	Livestock farming is more water intense than crop cultivation and can lead to groundwater pollution due to improper manure disposal. Water savings can reduce vulnerability e.g. to climate change induced water stress.
Co-benefits	Improved consumer health due to reduction in saturated fats Reduced costs on healthcare systems
Potential indicators	Number or area of livestock Share of food energy supplied by plant-based food
Assumptions and preconditions	Use of low impact farming methods, e.g. using natural soils, few greenhouses, ideally organic management (with low fertiliser input and hence low N_2O emissions) Large share of food is produced for the domestic market Knowledge and readiness for behaviour change in society Sufficient supply of plant-based food
Time schedule	Long: transformation of farming sector, behavioural change of society
Proposed steps to determine GHG emission impacts and Emission Factors	1. Determine the amount of cereals, legumes, nuts providing the same amount of carbohydrates, proteins, fat as 1MJ of meat and 1MJ of cheese/dairy products 2. Determine the emission factors per MJ of meat and of cheese/dairy product, and of the plant-based functional equivalents 3. Determine agricultural surface needed to produce 1MJ of meat and of cheese/dairy product, and surface needed to produce plant-based functional equivalents 4. Compute the amount of food energy (in MJ) brought by meat and dairy products that is shifted to a plant-based equivalent in the baseline and in the CE scenario 5. Calculate the amount of GHG saved due to change in diet GHG emissions savings = (GHG emissions of meat + cheese/dairy food substituted by plant-based functional equivalent) - (GHG emissions of the plant-based functional equivalent) + (carbon stock of land other than cropland - carbon stock of cropland) * (agricultural surface needed to produce the meat + cheese/dairy products - agricultural surface needed for the plant-based functional equivalent)
IPCC Guidelines volumes, chapters, and worksheets	Volume 3: IPPU: Worksheet 2H2 Food and Beverages Industry Volume 4: Agriculture, Forestry and Other Land Use: Livestock: worksheets 3A1 Enteric Fermentation, 3A2 Manure Management; Land: worksheets 3B1a - 3B4a, 3C4 Direct N_2O Emissions from Managed Soils
Data needs	Emission factors of meat and of cheese/dairy products, per MJ of food energy and of the plant-based functional equivalents Agricultural surface, soil, water, and fertilisers needed to produce 1MJ of meat and of cheese/dairy product, and the surface needed to produce the functional equivalents
Further guidance, research, and tools	European Commission, Zibell, L., Cuervo Blanco, T., Ellerbeck, A. et al. (2023), Study on the long-term linkages between climate objectives, international trade and investment – Annex 6: methodology to determine plant-based functional equivalents EX-Ante Carbon-balance Tool (EX-ACT) The Cool Farm Tool
Covered in NDCs	Not found

AFN4: Improve soil health through regenerative agricultural practices (adaptation)	
CE category	6.1 Increase share of sustainably sourced biobased materials
Product group	Food and feed
Context	In agriculture, regenerative practices such as no-till agriculture, use of cover crops, diverse crop rotation techniques and others can improve soil health and its capacity to store water and nutrients, enhancing soil resilience to the impacts of slow-onset climate change processes (e.g. changes in the precipitation patterns or temperature) and extreme weather events (e.g. droughts, floods, wind, etc.), which can cause erosion and salinisation.
Instruments for implementation	National/regional: update agriculture subsidy schemes incentivizing regenerative practices Local: Share information and offer trainings on regenerative practices
Potential GHG mitigation impact	Enhanced carbon sequestration capacity in soils (can be measured by increase of Soil Organic Content (SOC) per hectare) Reduction in the need for nitrogen-based fertilisers and respective GHG emissions from their production and use
Co-benefits	Reduced expenses of farmers in fertilisers and pesticides Improved biodiversity in the soil and above ground Reduced unmanaged disposal or landfilling of agricultural organic waste Protection of water resources through reduced application of pesticides
Potential indicators	Monitoring of soil health indicators: SOC, Salinisation (Electrical Conductivity), Soil erosion rate, Bulk density in subsoil (sub-soil compaction), Soil water holding capacity of the soil sample, Soil basal respiration (mm^3 O_2 g-1 hr-1) in dry soil
Assumptions and preconditions	Sustainable Soil Management Practices are: (1) chosen with the advice of qualified soil experts; (2) implemented consistently over several years; (3) regularly monitored for effectiveness and possible adjustment. Safety regulations and technical standards for compost or digestate are used as organic fertiliser for food crops is applied. Adopting regenerative practices increases the competitiveness of small farmers.
Time schedule	Medium to long: Changes in soil health typically show effects after at least 5 years
Description of Climate Risk	Climate Hazard: Increased frequency and/or intensity of slow-onset processes (e.g. changes in precipitation patterns) or extreme weather events (e.g. floods, droughts, strong storms) which can cause soil erosion, increased salinisation and loss of nutrients and therefore soil degradation Exposure: Agricultural lands and crops in regions prone to soil degradation Vulnerability: Sensitivity of farmers relying on fertile soil for crop productivity. → Improved soil health reduces risk of soil degradation
Data needs	Measurements of SOC per hectare Quantification of the surface covered by each relevant category of soil Water holding capacity
Further guidance, research, and tools	Africa Regenerative Agriculture Study Group (2021): Regenerative agriculture in Africa Gosnell et al (2019): Transformational adaptation on the farm: processes of change and persistence in transitions to 'climate-smart' regenerative agriculture. In: Global Environmental Change, 59 Zebisch, M. et al. (2023). Climate Risk Sourcebook. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.
Covered in NDCs	Costa Rica (mentioned as part of contribution 10.3), UAE (mentioned as part of food systems transformation)

CON1: Reduction of individual space in buildings

CE category	2 Reduce service level to reduce size and mass
Product group	Mineral-based (a-biotic) products Durable plant-based (biotic) products (e.g. wood)
Context	The reduction of building space per individuum can reduce emissions from energy use for heating and cooling. It also decreases additional construction needs, and thereby the need for producing and transporting building materials. This activity can be implemented through changing the space distribution in existing buildings or designing new buildings with a reduced individual space setup.
Instruments and products for implementation	National: Policies and legislation updates and implementation; standards and regulations incl. on housing subsidies and taxation Municipal: Urban development planning, financial support and permitting, management of public building stock
Potential Climate adaptation impact	Indirect effects e.g. on reducing urban heat island effects are possible. However, these are difficult to measure, and it is not recommended to consider these for climate reporting.
Co-benefits	Financial savings from reduced energy and resources costs for less building space
Potential indicators	Distribution curve for m^2 of floor space per (envisioned) occupant for new buildings Average m^2 of floor space per (envisioned) occupant for new or refurbished buildings
Assumptions and preconditions	Smaller spaces are politically, commercially, and publicly accepted. Security and evacuation of additional occupants must be fully guaranteed. The thermal insulation and material requirements do not change significantly Fossil fuels continue to have a significant role in building heating/cooling, and in construction and material production.
Time schedule	Short: Change of individual buildings Long: Significant reduction in living and office space size is expected to take many years particularly if the change only happens in new buildings
Proposed steps to determine GHG emission impacts and Emission Factors	Estimate individual energy use for reduced floor area and compare to individual energy use for current average floor area. For new buildings, estimate material footprint per individual area and compare to current standard. The amount of annual GHG emissions per m^2 constructed varies between building types, countries and individual buildings and their energy sources. No standard emission factor is available - on cement production: e.g. ID 213926 in emission factor database on tonnes of CO_2/tonne clinker produced
IPCC Guidelines volumes, chapters, and worksheets	Volume 2: Energy: Chapter 2 Stationary Combustion (tables 2.9 ad 2.10) and IPCC 2006 Categories 1A4a Commercial/institutional, 1A4b Residential Volume 3: IPPU: Chapter 2 Stationary Combustion (Chapter 2.2) and worksheet 2A1 Cement Production; Chapter 4.2 and worksheet 2C1 Iron and Steel Production Volume 4: Agriculture, Forestry and Other Land Use: Chapter 12 Harvested Wood Products (3D1), Chapter 12 Harvested Wood Products (3D1)
Data needs	Energy use over floor area (e.g., MWh or GJ/m^2/year) - national or regional averages, building-type specific Composition of energy use Emission factors of fuels or electricity Material footprint over floor area, by type of material, for existing and new buildings -or: Material flow analysis for construction in a country and scenarios for reduction thereof due to proposed policies.
Further guidance, research, and tools	Embodied Carbon in Construction Calculator (EC3) Tool
Covered in NDCs	China (revision of urban floor space development target)

CON2: Repurpose Buildings Usages

CE category	4 Increase lifetime
Product group	Mineral-based (a-biotic) products Durable plant-based (biotic) products (e.g. wood)
Context	Repurposing old buildings can prevent the construction of new buildings, and can significantly reduce emissions associated with construction, in particular CO_2 emissions from the production and transport of materials and energy used in construction.
Instruments and products for implementation	National: Policies and legislation updates and implementation, standards and regulations incl. building pricing and taxation Municipal: Urban development planning, management of public building stock, financial support and permission, pilot repurposing of a few buildings with additional public support to draw attention to the approach
Potential climate adaptation impact	Indirect: Avoided land use change - reduced need for construction materials and space might relieve pressure on natural resources and limit the conversion of land into settlements. This land could in turn contribute to enhanced climate resilience, e.g. cooling forest areas or buffer zones to absorb extreme water levels.
Co-benefits	Financial savings due to reduced construction activities
Potential indicators	Ratio of buildings repurposed over buildings demolished
Assumptions and preconditions	Reduced demand for former building purpose, preventing the construction of additional buildings serving the former purpose Market-analysis of the building type need(s) and public cost-benefit analyses to perform holistic comparisons between new and existing build-up sectors are required
Time schedule	Medium to long: repurposing of older public sector buildings, e.g. via public procurement; private sector transformation
Proposed steps to determine GHG emission impacts and Emission Factors	Assess/estimate GHG emissions from new building construction including energy use and transport of materials and deduct share of avoided new buildings. Calculate emission saved due to avoided new buildings. Amount of annual avoided GHG emissions per m^2 of not newly constructed floor space due to repurposing will vary per country/region and building type due to variation in energy sources and architecture.
IPCC Guidelines volumes, chapters, and worksheets	Volume 2: Energy: Chapter 2 Stationary Combustion (1A2 Manufacturing industries & construction) Volume 3: IPPU: Chapter 4.2 and worksheet 2A1 Cement Production, Chapter 4.2 and worksheet 2C1 Iron and Steel Production Volume 4: Agriculture, Forestry and Other Land Use: Chapter 12 Harvested Wood Products (source category 3D1)
Data needs	Energy use over floor area (e.g., MWh or GJ/m^2/year) in traditional building purposes - national or regional averages, or building-type specific. Composition of used energy sources Emission factors of fuels or electricity
Further guidance, research, and tools	Embodied Carbon in Construction Calculator (EC3) Tool
Covered in NDCs	Not found

CON3: Use of Substitute Cementitious Materials (SCMs) in cement	
CE category	6.1 Increase share of sustainably sourced biobased materials 6.2 Increase share of secondary materials
Product group	Mineral-based (a-biotic) products.
Context	Cement production is responsible for approx. 5-8% of global anthropogenic CO_2 emissions and expected to grow by 12-23% by 2050. Clinker minerals are the main constituents of common cement types. A reduced clinker factor by 10% can result in a 5-10% reduction in CO_2 emissions per tonne of cement produced. Substitute Cementitious Materials (SCMs) are often industrial waste or naturally occurring products and can substitute part of the clinker and its energy intense production.
Instruments for implementation	National: Update in regulations, norms, public procurement; (carbon) pricing policies with the objective to gradually reduce the share of clinker in cement by replacing it with SCMs Local: support the recovery and processing of SCMs for cement production
Potential Climate adaptation impact	n/a
Co-benefits	Financial savings from reduced energy consumption, as clinker production is a thermally intensive process Reduced consumption of raw materials Some SCMs might contribute to producing stronger cement
Potential indicators	Clinker substitution rates by selected materials, relative to reference cement norms (e.g. EN 197-1 Cement)
Assumptions and preconditions	SCMs with low GHG emission potential, such as fly ash or natural pozzolanic materials are available.
Time schedule	Short: national product regulation and standard alignment; Medium: construction sector adaptation to new cement types.
Proposed steps to determine GHG emission impacts and Emission Factors	Determine alternative and reference emission factors to compare the impact of changes in cement composition. Calculate emissions saved by changing cement composition Alternative emission factors will depend on the composition, and degree of substitution of clinker. Indicative global reference emission factors include ID 213926 in the emission factor database with a factor (EFclc) for clinker of 0.52 tonnes CO_2/tonne clinker produced. Other emission factors see IPCC 2006 category 2A1. Emission Factors for fossil energy use in cement production must also be considered. These are included in the IPCC 2006 category 1A2f.
IPCC Guidelines volumes, chapters, and worksheets	Volume 2: Energy: Chapter 2 Stationary Combustion Worksheet: 1A2f, non-metallic minerals Volume 3: IPPU: Chapter 2 (2.2): Cement Production Worksheet: 2A1, cement production and sheets in Annex 1 (p. A1.4)
Data needs	Clinker substitution rates for alternative SCM in a specific application/cement type. GHG emission intensity of clinker production Lifecycle data and GHG emission assumptions for SCMs to substitute clinker
Further guidance, research, and tools	TNO/PBL (2021): Decarbonisation options for the Dutch cement industry Cheng, D. et al. (2023): Projecting future carbon emissions from cement production in developing countries. In: Nat Commun 14.
Covered in NDCs	Indonesia, Jordan, Rwanda, South Sudan, UAE, Uganda and others

CON4: Reduction of steel use through design adjustments	
CE category	5.2 Reduce mass of a final product or service
Product group	Mineral-based (a-biotic) products (buildings)
Context	Steel production involves energy-intensive processes, often relying on fossil fuels for heat generation and chemical processes, e.g. coking coal. The global steel industry is responsible for about 6-7% of global anthropogenic GHG emissions. Targeted design adjustments, for example for beams and columns can reduce the material need without threatening the building structural integrity. The main source of GHG emission reduction in this activity is the reduction of steel use and its energy intense production processes.
Instruments for implementation	National: update policies and standards, stimulation through public procurement, standards and regulations on reducing steel use in buildings. Municipal: integration into education curricula where applicable and training of technical knowledge and capacities
Potential climate adaptation impact	n/a
Co-benefits	Reduced costs for steel Opportunities for job creation and knowledge/excellence in advanced construction
Potential indicators	kg of steel per floor surface area (xx kg/m²); or building volume (xx kg/m³); steel mass percentage in total material mass (xx%).
Assumptions and preconditions	The integrity of the building remains unaffected by the design adjustments. Steel is not replaced by GHG intense material such as cement. The average overall size of buildings does not significantly change.
Time schedule	Long: Transformation of the construction sector and building stock
Proposed steps to determine GHG emission impacts and Emission Factors	1. Determine the reduced share of steel use in the alternative option relative to national standard building practices or to international good practices 2. Determine a reference emission factor of the (national) steel industry - see e.g. IPCC emission factor database searching for IPPU category 2C1 (iron & steel) 3. Consider GHG emission savings from avoided combustion processes in steel production, e.g. see energy category 1A2 (Energy – Fuel combustion - Manufacturing industries and Construction–Iron and Steel) 4. Calculate GHG emissions saved by applying the alternative option
IPCC Guidelines volumes, chapters, and worksheets, links to EFDB	Volume 2: Energy: Chapter 2 Stationary Combustion. Worksheets: 1A2a steelmaking Volume 3: IPPU: Chapter 4.2 Iron & steel and Metallurgical Coke Production. Worksheets; 2C1 - iron and steel production
Data needs	Origin and composition by production process type of nationally used steel Estimates of steel reduction shares of alternative design options
Further guidance, research, and tools	Embodied Carbon in Construction Calculator (EC3) Tool D'Amico et al (2018): Sustainability Tool to Optimise Material Quantities of Steel in the Construction Industry. In: Procedia CIRP, Volume 69
Covered in NDCs	Not found

CON5: Reduction of concrete use through design adjustments	
CE category	5.2 Reduce mass of a final product or service
Product group	Mineral-based (a-biotic) products (buildings)
Context	Reinforced concrete consists of cement and (in most cases) steel, both materials are produced in energy-intensive ways, often using fossil fuels for heat and chemical processes, e.g. coking coal and for clinker production. Additionally, minerally bound CO_2 is emitted from the raw material in the clinker production process. Adjustments in the design of building elements could reduce the need for concrete and corresponding GHG emissions from its production.
Instruments for implementation	National: update policies and standards, support for activities, stimulation through public procurement, e.g. as part of a larger initiative on buildings Local: integration into curricula and training; specific capacity development trainings
Potential Climate adaptation impact	n/a
Co-benefits	Job creation in advanced construction methods, however this might happen at the cost of traditional jobs in construction
Potential indicators	kg of concrete per floor surface area (e.g., xx kg/m^2); or building volume (xx kg/m^3); concrete mass percentage in total material mass (xx%);
Assumptions and preconditions	Design changes do not negatively affect the building integrity. Concrete is not replaced by alternative with a large GHG emissions footprint. The average overall size of buildings does not significantly change.
Time schedule	Long: Transformation of the construction sector and building stock
Proposed steps to determine GHG emission impacts and Emission Factors	1. Determine the percentage reduction in concrete use in the alternative design option relative to national standard or use international values 2. Determine the material shares of cement and steel in national standard concrete; 3. Determine the reference emission factors or use international standards for cement and steel, e.g. for cement see ID 27508 in emission factor database, with default value: 0.4985 tonne CO_2/tonne cement produced; for other emission factors check 2006 category 2A1. 4. Consider GHG emissions from fossil fuel combustion in the production of cement and steel, see category 1A2 5. Calculate the amount of avoided GHG emissions per tonne of concrete, using the mentioned concrete design reduction percentage, material shares, and reference steel and cement emission factors
IPCC Guidelines volumes, chapters, and worksheets	Volume 2: Energy: Chapter 2 Stationary Combustion. Worksheets: 1A2a steelmaking;1A2f - non-metalic minerals, and 1A2k - construction Volume 3: IPPU: Chapter 2: Mineral Industry Emissions Worksheet: 2C1 Iron and Steel Production
Data needs	Origin and composition by production process type of nationally produced and consumed steel and cement Estimates of steel reduction shares of alternative design options
Further guidance, research, and tools	Embodied Carbon in Construction Calculator (EC3) Tool
Covered in NDCs	Not found

CON6: Increased longevity of buildings	
CE category	4. Increase lifetime
Product group	Mineral-based (a-biotic) products; Durable plant-based (biotic) products (e.g. wood);
Context	An extended lifetime of buildings reduces the need to construct new ones, thereby avoiding GHG emissions from the extraction, production and transport of materials, and from energy use in construction. In addition, emissions from deconstructing existing structures and valorising or disposing their materials can also be avoided. Approaches for increased longevity include for example.
Instruments for implementation	National: Building policies, including pricing and taxation; develop and adopt standards for increased longevity of buildings, e.g. through proactive maintenance, frequent inspections and the use of durable materials and elements, considering local conditions including potential climate change impacts, ease of replacing of worn-out/end-of-life-cycle materials, incorporating flexibility in the design, which facilitates future modifications and renovation as well as raising quality standards for specific materials (see also CON7) Municipal: Management of public building stocks/financial support and permitting
Potential climate adaptation impact	Indirect: Avoided land use change - reduced need for construction might relieve pressure on natural resources and limit the conversion of land into settlements. This land might in turn contribute to enhance climate resilience, e.g. cooling forest areas or buffer zones to absorb extreme water levels.
Co-benefits	Cost savings due to reduced construction of new buildings Expertise and employment in advanced construction design methods
Potential indicators	Distribution curve of age of buildings Average age of buildings when being demolished.
Assumptions and preconditions	Standards for increased longevity of buildings are realistic and technically and economically feasible; buildings are not less energy efficient than the old standard.
Time schedule	Long: Change in physical buildings stock
Proposed steps to determine GHG emission impacts and Emission Factors	Estimate the reduction in new buildings constructed compared to a baseline or Business as Usual Scenario; Multiply the number of reduced buildings with the estimated GHG resulting from each construction. Calculate net emission reductions No standard emission factor is available - The amount of annual GHG emissions avoided per m² not newly constructed floor varies per building type, country and other aspects.
IPCC Guidelines volumes, chapters, and worksheets, links to EFDB	Volume 2: Energy: Chapter 2 Stationary Combustion 1A4a, Institutional/commercial (ch. 2, table 2.10), 1A4b Residential (ch. 2, table 2.9); 1A2 Manufacturing industries, construction (ch. 2.3.3.1) Volume 3: IPPU: Chapter 2: Mineral Industry Emissions. Worksheet: 2A Mineral Industry Volume 4: Agriculture, Forestry and Other Land Use: Chapter 12: Harvested Wood Products Worksheet: 3D1 Harvested Wood
Data needs	Building stock age distributions Age distribution for demolished buildings Estimates of renovation impact on building longevity Average age of key building materials
Further guidance, research, and tools	Embodied Carbon in Construction Calculator (EC3) Tool
Covered in NDCs	Not found

CON7: Modular Building Design (adaptation)	
CE category	5.1 Substitute a technical solution by a more material-efficient one
Product group	Mineral-based (a-biotic) products Durable plant-based (biotic) products (e.g. wood)
Context	The consideration of modular elements in building design facilitates the adaptation of buildings to changing climate patterns. Adopting a modular approach, standardized building types leave room for potential design changes using reusable modules. Buildings could then be adapted to changing climate conditions. For instance the subsequent installation of reflective roofing materials could increase resilience to heat waves that were unexpected at the time of building completion or permeable paving modules for external areas around the building could absorb impacts of heavy precipitation events. This approach can help if future climate conditions are unclear, as it allows for modular changes. At the same time, the approach reduces the need for new buildings with respective resources extraction and production. If broadly introduced, modular elements can be reused.
Instruments for implementation	National: Change of building codes and regulations, allowing and incentivizing modular design approaches, updates in public building planning processes Local: Consideration of modular approaches in public construction planning, support to local businesses embracing modular design.
Potential GHG mitigation impact	Avoided GHG emissions from the reduced need for construction of new buildings and extensive remodelling activities including extraction, processing and transport of resources, materials, and products
Co-benefits	Development of expertise and employment in modular building design Environmental protection as extraction of raw materials and new construction works can be reduced Long term financial savings due to avoided construction costs
Potential indicators	Floor area in m² of modular buildings Share of modular buildings in the public building stock Yearly building construction (e.g. in permits, dwellings, or floor area in m²)
Assumptions and preconditions	The number of modular buildings constructed after several years is sufficient to facilitate their maintenance in cost efficient way. Reuse of modules is economically viable (the larger the modular building stock, the more cost-efficient). The approach provides for incorporating potential future technological advances. Technical capacity, skilled workforce and materials are available and affordable.
Time schedule	Long: Notable change in overall building stock towards modularity takes many years
Description of Climate Risk	Climate Hazard: Increased frequency and/or intensity of extreme weather events such as storms, floods, or heatwaves, which can damage buildings or threaten their long-time integrity. Exposure: Buildings and their residents situated in areas prone to extreme weather events. Vulnerability: Sensitivity of buildings to be damaged by weather events and sensitivity of building users (residential or commercial) to these events, e.g. heat waves. → Modular approaches reduce the vulnerability of buildings and their users through flexible design changes and replacement of individual parts if damaged.
Data needs	Yearly construction of buildings, including modular ones Forecast of floor area needed for residential and commercial purposes Share of modular designed parts of buildings
Further guidance, research, and tools	n/a
Covered in NDCs	Monaco mentions modular green walls as part of green buildings infrastructure

MOB1: Public Transport	
CE category	5.1 Substitute a technical solution by a more material-efficient one
Product group	Mineral-based (a-biotic) products: Passenger cars
Context	The number of individual cars has increased in the last decades to almost 1.5 billion globally in 2024. The production and operation of cars require significant amounts of non-renewable resources and fossil fuels, if powered by internal combustion. Disposing of old cars generates substantial waste, including hazardous materials. Public transport vehicles, such as buses, trains, and tramways on average transport more passengers per kilometre, translating into less GHG emissions from both production and operation per individual person. Estimates suggest that buses and trains can reduce GHG emissions by up to two-thirds per passenger and kilometre.
Instruments for implementation	National, regional, and local (urban): Support the construction and use of public transport systems, including through infrastructure planning, financial incentives such as subsidies, plan for ticketing, coherent and inter-operable networks to increase commuter convenience, and potential public and/or private transport companies. Material and construction planning might involve among other elements vehicles, reserved lanes, higher parking prices and reduced parking spaces for individual cars in central urban areas, railways network (tramway or heavy rail).
Potential climate adaptation impact	New public transport system design should consider the potential impacts of climate change and variability, including both slow-onset and extreme weather events. Measures for improved climate resilience might include e.g. stormwater drainage systems, bus and train stops with heat-resistant roofs, etc. Reduced space demand for individual cars can increase alternative uses for streets such as parks and trees, which can increase climate resilience within urban areas.
Co-benefits	Public transport can reduce traffic congestion as well as pollution and noise Macroeconomic savings from higher collective cost efficiency of passenger transport Creation of employment in public transport
Potential indicators	Share of passenger kilometres performed in public transport compared to total
Assumptions and preconditions	Baseline to which to compare is the currently used modes of transport, including individual passenger cars, public transport as well as walking and cycling.
Time schedule	Medium to long: Planning and implementation of bus networks. Long: Planning and construction of new or extended tramway and/or train network
Proposed steps to determine GHG emission impacts and Emission Factors	1. Determine mass of each basic metal, glass, and plastic per functional unit of each mode of transport (e.g. passenger car, motorbike, bus, tram, train) 2. Estimate GHG emission factors for each kg of basic metal, glass and plastic, and per MJ of electric energy and of fossil fuel 3. Estimate passenger kilometres performed per functional unit of mode of transport over its lifetime, and per MJ of energy 4. Estimate GHG emissions per passenger km in each mode of transport 5. Estimate modal shift (expressed in passenger kilometres) between modes of transport in the scenario with and without implementation of the measure 6. Calculate net GHG emission reductions compared to baseline
IPCC Guidelines volumes, chapters and worksheets	Volume 2: Energy: All Chapters. Worksheets: For operation: 1A3 bi Cars, 1A3 biii Heavy-duty Trucks and Buses, 1A3 biv Motorcycles, 1A3 c Railways; for manufacturing: 1A2 a Iron and Steel, 1A2 b Non-Ferrous Metals, 1A2 c Chemicals, 1A2 g Transport Equipment Volume 3: IPPU: All Chapters. Worksheets: 2A3 Glass Production, 2B8b Ethylene, 2B8c Ethylene Dichloride and Vinyl Chloride Monomer, 2B8d Ethylene Oxide, 2C1 Iron and Steel Production, 2C2 Ferroalloys Production, 2C3 Aluminium Production
Data needs	Composition of transport elements and their individual GHG emission factors Estimates on car occupancy and projected public transport use Travelled kilometres by each mode of transport
Further guidance, research, and tools	Carroll et al. (2019): Measuring the potential emission reductions from a shift towards public transport, Transportation Research Part D: Transport and Environment, Volume 73, Pages 338-351,
Covered in NDCs	Bolivia, Cambodia, Egypt, Mexico, South Africa, Tanzania, Uganda and many others

IPP1: Increased purity of recycled aluminium

CE category	6.2 Increase share of secondary materials
Product group	Mineral-based (a-biotic) products (e.g. buildings, cars, domestic appliances)
Context	The recycling of aluminium can reduce the need for primary aluminium production and thereby the associated GHG emissions, including CO_2 from energy consumption as well as direct emissions of perfluorocarbons (PFCs) such as tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) during manufacturing. Estimates suggest that energy needed to melt aluminium from scrap is approximately 5% of the energy consumed in ore reduction. However, the specific usability of aluminium for recycling depends among other factors on its purity.
Instruments for implementation	National level: policies restricting the variety of alloys allowed for recycled aluminium; development of industry-wide standards or regulations that specify the alloy varieties permissible for different applications, aiming to simplify the range of alloys used and recycled; It is recommended to use or build on existing standards and if possible, coordinate with additional countries. Local level: Targeted trainings and adopted education curricula; investment in advanced sorting and processing technologies
Potential climate adaptation impact	n/a
Co-benefits	Reduced energy consumption as recycling of pure aluminium requires less energy More efficient recycling processes Reduced need for raw materials (for primary aluminium production), reduced waste
Potential indicators	Amount or share of pure recycled aluminium Documented change in energy required for the recycling of aluminium Reduction in impurities and increase in the uniformity of the recycled aluminium
Assumptions and preconditions	Technology to efficiently sort and process specific alloys is available. Less energy intense recycling processes for higher purity aluminium are developed and ready to be implemented. Markets adapt to using fewer alloy varieties in products.
Time schedule	Medium to long: transition of the industry to implement change of policies in their manufacturing processes
Proposed steps to determine GHG emission impacts and Emission Factors	1. Baseline Emission Evaluation 2. Determine Emission Factors for Pure Recycling 3. Assess Alloy Restriction Impact 4. Calculate Net Emission Reductions 5. Incorporate Industry Adaptation
IPCC Guidelines volumes, chapters, and worksheets	Volume 2: Energy: Fuel combustion activities: 1A2 Manufacturing Industries and Construction; 1B2 Fugitive Emissions from Oil & Gas; Mining and Quarrying Volume 3: IPPU: 2A Mineral Industry, 2B Chemical Industry, 2C Metal Industry; 2E Electronics Industry
Data needs	GHG emissions intensity for the manufacturing of 1 tonne of the primary basic product being considered Estimated amount of aluminium required/planned to be produced nationally
Further guidance, research, and tools	Raabe et al. (2022): Making sustainable aluminum by recycling scrap: The science of "dirty" alloys. Progr. in Materials Science, Elsevier, 10.1016/j.pmatsci.2022.100947
Covered in NDCs	Not found

IPP2: Increase the recycling content in plastics

CE category	6.2 Increase share of secondary materials
Product group	Mineral-based (a-biotic) products: Plastics
Context	Melting a mix of plastic varieties (high/low density PE, PET, PP, PVC etc.) together for recycling results in a product with a significant and irreversible loss in material functionalities. A high level of purity in recycled plastics improves its usability and the potential for another recycling cycle. This reduces GHG emissions from burning non-recycled plastic waste, and the need for new fossil-based plastics and the associated GHG emissions from its production.
Instruments for implementation	National: Policies, regulations, and technical standards for reducing the variety of additives of plastics, including lists of allowed sorts of plastics per application (e.g. food packaging, detergent packaging); it is recommended to use or build on existing standards; introduction of a digital product passport or material passport can further increase sorting and recycling performance Local: Targeted trainings in plastic industry and adopted education curricula
Potential climate adaptation impact	n/a
Co-benefits	Reduced plastic pollution and less waste, as plastic recycling increases Employment in the recycling industry
Potential indicators	Share of recycled plastic in new products
Assumptions and preconditions	Public authorities are trained and mandated to perform controls and impose sanctions if necessary.
Time schedule	Medium to long: introduction of recycling standards and adjustment of approaches, technical requirements for monitoring and reporting, and for sorting and recycling equipment
Proposed steps to determine GHG emission impacts and Emission Factors	For each application of plastic (e.g. food packaging, detergent packaging): 1. Quantify the share of recycled plastic in the total plastic supply (Circular Material Use Rate) in a baseline scenario 2. Estimate the share of residual virgin plastic that would need to be fed to the system in the scenario of full adoption of the measure 3. Quantify the total mass of (virgin or recycled) plastic needed to satisfy the demand for that application of plastic (scenario modelling based on past trends) 4. Estimate the GHG emission intensity of virgin plastic, used in this application of plastic & GHG emission intensity of recycled plastic with the same functionality 5. Calculate net emission reductions from recycled as compared to virgin plastic 6. Estimate the GHG emissions intensity of the incineration of plastic waste Savings in GHG emissions = (GHG emissions intensity of virgin plastic + GHG emissions intensity of the incineration of fossil based plastic waste) x [(share of recycled plastic in the scenario of implementation of the measure) - (share of recycled plastic in the baseline scenario)] x (Total mass of plastic needed to satisfy the demand). An example of an IPPU-related GHG emission factor of producing a plastics component is ID 214027 in the emission factor database, CO_2 emissions of ethylene production (outside NAm, LAm, and AUS): 1.73 tonne CO_2/tonne of ethylene.
IPCC Guidelines volumes, chapters and worksheets	Volume 2: Energy: Chapter 2: Stationary Combustion Worksheets: 1A2c - Chemicals Volume 3: IPPU: Chapter 3 (3.9): Petrochemical and carbon black production. Worksheets: 2B8 - Petrochemical and Carbon Black Production - 2B8a to 2B8e concern chemical elements for plastics Volume 5: Waste: Worksheets: 4C. Incineration and open burning of waste
Data needs	Material Flow Analysis of domestic plastic waste streams for each application LCA data with emission factors for producing, recycling and incinerating plastics Amount of virgin and recycled plastic produced and incinerated nationally
Further guidance, research, and tools	n/a
Covered in NDCs	Not found

IPP3: Use bio-based feedstock for the production of organic chemicals	
CE category	6.1 Increase share of sustainably sourced biobased materials
Product group	Durable plant-based (biotic) products: Chemicals
Context	The production of chemicals is a potential source of GHG emissions. These might be reduced by using bio-based input resources instead of fossil-based ones. However, replacement with low emission bio-based feedstock is not a guarantee for emission reduction, as emissions arise from the specific production process of the feedstock. Examples include the generation of volatile fatty acids as basic resource for the chemical industry or the extraction of concentrated Ammonium (NH_4) for industrial or agricultural uses.
Instruments for implementation	National: Enabling policy and framework conditions environments, e.g. through recycling targets and funding programmes facilitating a business case for the use of bio-based feedstock; strategy to safeguard the sustainability of bio-based feedstock; Set framework conditions for gradually replacing a share of fossil-based resources for chemical production by bio-based resources
Potential climate adaptation impact	n/a
Co-benefits	Reduced environmental pollution caused by extraction and processing of fossil-based materials
Potential indicators	Share of bio-based feedstock as input for organic chemicals Quantity of bio-based feedstock diverted to organic chemical production
Assumptions and preconditions	Resources for bio-based feedstock are economically available to chemical industry. The competition over bio-based resources, e.g. for food security, is not significant. Technologies to use bio-based feedstock are developed and ready for use. Tracking of organic chemical production, separated by feedstock used, is active.
Time schedule	Long: Some of the technologies are still in the phase of development
Proposed steps to determine GHG emission impacts and Emission Factors	1. Determine GHG emissions per tonne of organic chemical based on feedstock type and chemical type 2. Determine total amount of organic chemical used based on feedstock type 3. Calculate Net Emission Reductions Example of calculations for saving, for each organic chemical type: (Total use of the organic chemical) x [(Share of bio-based feedstock under a scenario with bio-based feedstock use) - (Share of bio-based feedstock use under a baseline scenario)] x [(GHG emissions intensity of organic chemical based on fossil fuel feedstock) - (GHG emission intensity of organic chemical based on bio-based feedstock)]
IPCC Guidelines volumes, chapters, and worksheets	Volume 2: Energy: Worksheets: 1A2c Manufacturing Industries and Construction (i.e. when related to chemical production) Volume 3: IPPU: Chapter 3: Chemical Industry Emissions. Worksheet: 2B Chemical Industry
Data needs	GHG emissions intensity for the manufacturing of 1 tonne of the organic chemical being considered (both for fossil-based feedstock and bio-based feedstock) Volume of bio-based feedstock made available
Further guidance, research, and tools	Ramchuran et al. (2023): An overview of green processes and technologies, biobased chemicals and products for industrial applications, Current Opinion in: Green and Sustainable Chemistry, Volume 41, 2023
Covered in NDCs	Not found

PAC1: Substitute selected plastic products	
CE category	4 Increase lifetime 6.1 Increase share of sustainably sourced biobased materials 6.2 Increase share of secondary materials
Product group	Mineral-based (a-biotic) products (e.g. nylon and plastic bags)
Context	Plastic products use resources and energy in production with associated GHG emissions. Especially single use plastics are often discarded after one use. The reduction of plastic products, such as single use plastic bags and substitution with multiple use and/or bio-based products may lead to a reduction of emissions. Durable plastic products for multiple use can also be a viable alternative. However, careful life cycle assessments of all GHG emissions of alternatives need to be conducted to avoid negative system shifts, as the production of alternatives is often more GHG intense and only reduces emissions if used many times. GHG emissions can arise from the extraction and processing of resources and materials as well as from production and waste treatment. This activity can be applied to plastic packaging products, but also for plastic products beyond packaging.
Instruments for implementation	National: development of legislative, policy, regulation, and monitoring frameworks to eliminate or restrict the use of plastic products; Public awareness activities to increase acceptance and shift consumer behaviour; set reduction targets for reducing single use plastic, ban or introduce voluntary pacts for problematic products, incentive schemes for businesses to use alternative packaging, introduce greener production standards/disposable packaging tax Regional and municipal level: Support and capacity building for businesses in supply chain adaption; awareness campaigns for citizens to switch to alternative products
Potential climate adaptation impact	Less plastic pollution can protect ecosystems and their functions in enhancing climate resilience, e.g. providing clean freshwater, depending on climate risk context
Co-benefits	Reduced environmental pollution Less landfilling and burning of plastic with positive effects on air quality Innovation in sustainable materials, product design and product service systems with respective job opportunities
Potential indicators	Reduction of plastic waste, measured by the decrease in volume or weight of selected plastic products disposed of or collected, and/or plastic waste generated per person and day, national recycling rate as % of plastic waste (polymer) generated. Waste management efficiency: Indicators showing e.g. reduced landfill reliance, as a result of eliminating certain plastic products.
Assumptions and preconditions	Consumers and businesses accept the substitute products. Sustainable, cost-effective and less GHG-intense alternatives are available. Regulatory frameworks and incentives are established. Supply chains can accommodate changes in packaging requirements.
Time schedule	Long: change of supply chains, systems, and consumer behaviour
Proposed steps to determine GHG emission impacts and Emission Factors	1. Establish baseline emissions and emission factors of selected products including production and waste management 2. Identify emission factors for alternatives 3. Quantify targeted substitution of plastic use 4. Calculate estimated emission reduction
IPCC Guidelines volumes, chapters and worksheets	Volume 2: Energy: Chapter 2 Stationary Combustion (1A2c Chemicals) Volume 3: IPPU: Worksheet 2B8 Petrochemical and Carbon Black Production Volume 5: Waste: Chapter 3 Solid Waste Disposal, 4A Solid Waste Disposal and worksheet 4C Incineration and Open Burning of Solid Waste
Data needs	GHG emissions intensity for the production, disposal and/or incineration of 1 tonne of solid waste for plastic and alternative product Amount and share of targeted plastic and alternative products produced, imported and used nationally
Further guidance, research, and tools	n/a
Covered in NDCs	UAE (referring to existing policies on single use plastic bags and styrofoam containers in Abu Dhabi)

PAC2: Ecodesign requirements on packaging for recycling

CE category	6.2 Increase share of secondary materials
Product group	Durable plant-based (biotic) products for paper & cardboard packaging Mineral-based (a-biotic) products for glass, plastic, and metal packaging
Context	Traditional product design does not prioritize recyclability, resulting in waste that is difficult to process, and consequently in unsustainable resource use. Eco-design requirements aim to address this by setting clear standards and encouraging innovations e.g. in packaging design that support recycling, reduce GHG emissions from extraction of resources and linear waste treatment.
Instruments for implementation	National: Development of a policy, legal and regulatory framework incentivizing the adoption of eco-design criteria for packaging production and the use of these packaging products; development of eco-design technical standards specifying the conditions for packaging to be recyclable (e.g. on the assembly methods, the colours, inks, additives, and alloys); development of an enabling financial framework for producing competitive recyclable packaging at affordable costs, eco-modulation of fees along recyclability criteria in extended producer responsibility schemes. Regional/local: Support and capacity building for manufacturers in innovative packaging solutions, e.g. through training and academic curricula
Potential climate adaptation impact	Less plastic pollution might protect ecosystems and their functions in enhancing climate resilience, such as providing clean freshwater, depending on the specific climate risk context.
Co-benefits	More valuable packaging products can increase income generated from local waste collection, in particular by informal workers and other vulnerable groups Reduced packaging waste pollution Reduced amount of packaging waste load to be landfilled or burnt
Potential indicators	Share of packaging waste that is effectively recycled after separate collection Material produced adhering to eco-design criteria
Assumptions and preconditions	Most of the recyclable packaging is collected separately, processed in a recycling plant and its materials are fed into new packaging, with acceptable losses. Public authorities have the capacity and mandate to control service providers. Manufacturers have the technical capacity to produce recyclable packaging.
Time schedule	Medium to long: adapt manufacturing processes and install recycling facilities
Proposed steps to determine GHG emission impacts and Emission Factors	1. Determine GHG emissions per kg of virgin and recycled packaging materials: cardboard, glass, plastic (PET, polyethylene, polypropylene), steel, aluminium 2. Determine total consumption of each of the materials following historic trends 3. Define the share of recycled material for each of the materials under a baseline scenario and under a scenario of eco-design for recyclability implementation 4. Calculate GHG emission reductions due to introduction of substitutes Formula: GHG emission mitigation for each material used for packaging = (Total consumption of the material for packaging) x [(Share of recycled content under the scenario with eco-design requirements) - (Share of recycled content under a baseline scenario)] x [(GHG emissions intensity of virgin material) - (GHG emissions of recycled material)]
IPCC Guidelines volumes, chapters, and worksheets	Volume 2: Energy: Chapter 2 Stationary Combustion (1A2a Iron and Steel, 1A2b Non-Ferrous Metals, 1A2c Chemicals, 1A2d Pulp, Paper and Print) Volume 3: IPPU: worksheets 2A3 Glass Production, 2A4a Ceramics, 2B8b Ethylene, 2B8d Ethylene Oxide, 2C1 Iron and Steel Production, 2C2 Ferroalloys Production, 2C3 Aluminium Production, 2H1 Pulp and Paper Industry Volume 5: Waste: Chapter 3 Solid Waste Disposal (4A Solid Waste Disposal, 4B Biological Treatment of Solid Waste, 4C Incineration and Open Burning of Waste)
Data needs	GHG emissions per kg of virgin and recycled materials used for packaging Total consumption of each of the materials for packaging following historic trends Share of recycled material for each of the packaging products in a baseline scenario
Further guidance, research, and tools	n/a
Covered in NDCs	Not found

PAC3: Increase discarded packaging sorting and recycling efficiencies	
CE category	6.2 Increase share of secondary materials
Product group	Mineral-based (a-biotic) products (e.g. buildings, cars, domestic appliances)
Context	Discarded packaging material is often landfilled or burnt. The sorting and recycling of discarded packaging can reduce GHG emissions from producing the respective material such as virgin plastic, paper/cardboard, glass, steel, and aluminium. If packaging waste is burnt in the baseline scenario, the main source of GHG mitigation results from reduced burning of unsorted/unrecycled waste, including nitrogen oxides (NO_X), ammonia (NH_3) and black carbon. While this sheet focuses on packaging, the mechanism also applies to other products.
Instruments for implementation	National: policies and regulations incentivizing the separate collection, sorting, and recycling of packages (e.g. through refund systems), financial incentives for recycling Regional/local: support for packaging initiatives and public procurement of waste collection and recycling services; implement monitoring system; awareness campaigns and trainings, e.g. on correct waste segregation
Potential climate adaptation impact	Less packaging waste might protect ecosystems and their functions in enhancing climate resilience, such as providing clean freshwater, depending on the specific climate risk context.
Co-benefits	Potential for employment in recycling Reduced packaging waste load to be landfilled or burnt
Potential indicators	Estimated share or amount of packaging recycled, versus not recycled
Assumptions and preconditions	Improved waste sorting ratios lead to recovery of packaging waste for recycling. Improved recycling ratios lead to increased use of recycled materials in the production of new packaging (e.g. in plastic, depending on the polymer type). Waste separation is aligned with waste collection processes. Effective monitoring of material flows and collection, sorting and recycling is in place.
Time schedule	Medium to long: Installation and sustainable operation of sorting and recycling facilities
Proposed steps to determine GHG emission impacts and Emission Factors	Examples for emission factors in emission factor database (ID search): For waste incineration e.g. ID 622386: CO_2 emission factor (dry basis) = 1000 [kg]* carbon content * rate of combustion * 44/12 (molar mass of CO_2 and C) For solid waste disposal e.g. ID 62639: CH_4 emission factor for managed municipal solid waste disposal (US) = 2 kg CH_4/capita/year - though emissions can be differentiated per material, see IPCC Guidelines, Vol.5, Ch.3. Further factors for avoided emissions through reduced production of raw and primary packaging materials depend on the materials of the recuperated packaging waste.
IPCC Guidelines volumes, chapters and worksheets	Volume 2: Energy: Chapter 2 Stationary Combustion (1A2a Iron and Steel, 1A2b Non-Ferrous Metals, 1A2c Chemicals, 1A2d Pulp, Paper and Print Volume 3: IPPU: worksheets 2A3 Glass Production, 2A4a Ceramics, 2B8b Ethylene, 2B8d Ethylene Oxide, 2C1 Iron and Steel Production, 2C2 Ferroalloys Production, 2C3 Aluminium Production, 2H1 Pulp and Paper Industry Volume 5: Waste: Chapter 3 Solid Waste Disposal (4A Solid Waste Disposal, 4B Biological Treatment of Solid Waste, 4C Incineration and Open Burning of Waste)
Data needs	Material flows in packaging waste, and amount of packaging waste recovered through waste collection and separation. International emission factors for incineration (if applicable), or national emission factors of waste disposal sites; and applicable emission factors of manufacturing industries of packaging materials per kg or per tonne of material
Further guidance, research, and tools	US EPA Waste Reduction Model (WARM) for estimating emission savings of alternative materials management systems and practices (focus on US) Teichmann, D., Schempp, C. (2013): Calculation of GHG Emissions in Waste and Waste-to-Energy Projects. JASPERS working papers
Covered in NDCs	Japan (Promotion of sorted collection and recycling of plastic containers and packaging); UAE (mentions planned piloting of a closed-loop recycling model for plastic bottles and beverage cartons as an example)

TEX1: Ecodesign requirements for increasing the lifetime of textile articles	
CE category	4 Increase lifetime
Product group	Durable plant-based (biotic) products for natural fibres and materials Mineral-based (a-biotic) products for artificial/synthetic fibres and materials
Context	The textile industry uses large amounts of energy and water. When taking the whole supply chain into account, the share of global GHG emissions of the apparel and footwear industry was estimated at 8-10%. Mandatory design criteria for increasing the lifetime of textiles, as currently reviewed by the EU, can reduce the purchase of new textiles, decreasing their production and the respective GHG emissions. Eco-design criteria also often aim at increasing recyclability, which can reduce GHG emissions and environmental impacts from the production of new textile products.
Instruments for implementation	National: Develop and adopt policies, setup credit schemes supporting the purchase of longer-life products and other financial incentives; consider schemes of Extended Producer Responsibility, incentivize the reduction of post-consumer textile waste Local: Trainings in sustainable textile design according to eco-design standards
Potential climate adaptation impact	Reduction in the consumption and pollution of water to produce textiles decreases vulnerability to increased water scarcity caused by climate change and variability Reduction of waste in landfills, which might be exposed to extreme weather events Reduction of land used for natural and cellulosic fibre production, leaving space e.g. for food production in areas threatened by food insecurity due to climate change
Co-benefits	Reduced water, soil, and air pollution from textile manufacturing Employment in sustainable textile design and production
Potential indicators	Duration of use of discarded textiles, estimated through sample analyses of newly discarded articles: current date – estimated date of production or purchase Average amount of newly purchased textile articles from sale statistics or surveys
Assumptions and preconditions	Alternative employment opportunities and/or trainings are available for textile workforce, if the decrease in production requires less workers. A sufficient share of the textile products is used until the end of their life. Textile manufacturers have sufficient capacity to adopt eco-design standards.
Time schedule	Long: adjustment of manufacturing processes, business, and consumer behaviour
Proposed steps to determine GHG emission impacts and Emission Factors	1. Determine current usage duration of representative textile articles and estimate their future usage duration considering eco-design requirements 2. Estimate GHG emissions associated with production of these articles under the current design and with eco-design requirements 3. Determine textile consumption in a Business-as-Usual scenario and with implementation of the eco-design requirements including reduced volumes 4. Calculate emission reductions due to increased lifetime of textiles Reduction in GHG emissions for each textile article = (GHG emissions for 1 article under current design x consumption volume in baseline scenario) - (GHG emissions for 1 eco-design article x consumption volume with eco-design requirements)
IPCC Guidelines volumes, chapters, and worksheets	Volume 2: Energy: Chapter 2 Stationary Combustion: 1A2c Chemicals (synthetic fibres & materials), 1A2l Textile/Leather, 1A4c Agriculture (growing cotton etc.) Volume 3: IPPU: worksheets 2B1 Ammonia Production (fertilizers), 2B3 Adipic Acid Production (nylon production), 2B4 Caprolactam, Glyoxal and Glyoxylic Acid Production (nylon production and textile finishing), 2B8b Ethylene (polyester production), 2B8d Ethylene Oxide (polyester production) Volume 4: AFOLU: worksheets 3A1c Enteric fermentation, 3A2 Manure Management (wool), 3C3 Urea Fertilization, 3C4/3C5 Direct/Indirect N_2O Emissions from Managed Soils, 3C6 Indirect N_2O Emissions from Manure Management (cotton etc.) Volume 5: Waste: 4A Solid Waste Disposal, worksheets 4B Biological Treatment of Solid Waste, 4C Incineration and Open Burning of Waste
Data needs	Composition of typical textile articles, current and with ecodesign requirements Trends in production and consumption volumes of representative textile articles
Further guidance, research, and tools	EEB (2022): New EU eco-design proposals: Case studies to illustrate their potential impact
Covered in NDCs	Not found

TEX2: Repair textiles for reuse

CE category	4 Increase lifetime
Product group	Durable plant-based (biotic) products for natural fibres and materials Mineral-based (a-biotic) products for artificial/synthetic fibres and materials
Context	The production of textile products and respective GHG emissions from raw material extraction, processing, transport, and disposal can be reduced by improving conditions for repairing textile products.
Instruments for implementation	National level: policies to incentivize repair and reuse, such as Extended Producer Responsibility (EPR) schemes or tax breaks for repair businesses. Municipal level: technical and financial support for repair businesses, supporting manufacturers and retailers, awareness campaigns for citizens to maintain clothes and purchase second-hand instead of new items
Potential climate adaptation impact	Reduction in the consumption and pollution of water to produce textiles decreases vulnerability to water scarcity and quality caused by climate change and variability. Reduction of waste in landfills, which might be exposed to climate change impacts such as extreme weather events. Reduction of land used for natural and cellulosic fibre production, leaving space e.g. for food production in areas threatened by food insecurity due to climate change
Co-benefits	Reduction in textile waste amount and pollution through discarded textiles Employment and development of skills and expertise in repair
Potential indicators	Number of repair businesses including alterations, tailoring, and shoe repair Number of repairs performed by individual businesses or across a region
Assumptions and preconditions	Relevant domestic textile production industry exists. Alternative employment opportunities are available for textile workforce. Repair and reuse of textile products decreases the need to buy new products. Market demand for repaired second hand textiles increases.
Time schedule	Medium to long: Behavioural change of society towards longer maintenance
Proposed steps to determine GHG emission impacts and Emission Factors	1. Determine the consumption volume of representative textile articles and estimate their future production in a baseline scenario 2. Develop a consumption volume scenario with increased repair of textile products and estimate the effect on the reduction of textile production 3. Estimate GHG emissions from introducing and operating repair businesses 4. Calculate emission reductions from switching to an increased repairing scenario considering repair business emissions 5. Calculate the amount of mitigated GHG emissions Reduction in GHG emissions for each textile article = (GHG emissions for 1 article under current production volume in baseline scenario) - (GHG emissions for 1 article x consumption volume with increased repairs + GHG emissions for 1 article from building and operating repair businesses)
IPCC Guidelines volumes, chapters and worksheets, links to EFDB	Volume 2: Energy: Chapter 2 Stationary Combustion: 1A2c Chemicals (synthetic fibres & materials), 1A2l Textile and Leather, 1A4c Agriculture (growing cotton etc.) Volume 3: IPPU: worksheets 2B1 Ammonia Production (fertilizers), 2B3 Adipic Acid Production (nylon production), 2B4 Caprolactam, Glyoxal and Glyoxylic Acid Production (nylon production and textile finishing), 2B8b Ethylene (polyester production), 2B8d Ethylene Oxide (polyester production) Volume 4: AFOLU: worksheets 3A1c Enteric fermentation, 3A2 Manure Management (wool), 3C3 Urea Fertilization, 3C4/3C5 Direct/Indirect N_2O Emissions from Managed Soils, 3C6 Indirect N_2O Emissions from Manure Management (cotton etc.) Volume 5: Waste: 4A Solid Waste Disposal, worksheets 4B Biological Treatment of Solid Waste, 4C Incineration and Open Burning of Waste
Data needs	Current textile waste generation per capita Number of repair and renting shops for textile garments Amount of textile garments produced annually
Further guidance, research, and tools	n/a
Covered in NDCs	Not found

TEX3: Fibre-to-fibre textile recycling for cotton textiles	
CE category	6.2 Increase share of secondary materials
Product group	Durable plant-based (biotic) products
Context	The cultivation and processing of cotton require large amounts of water, land, and energy. Textiles made of 100% cotton can be recycled using advanced fibre to fibre technologies, which are currently in development, thus replacing part of the virgin cotton fibres with recycled fibres. GHG emission savings result from the reduced production of virgin cotton (mainly caused by cultivation and manufacture) and waste management, while emissions from the recycling process need to be added.
Instruments for implementation	National: policies and regulations for incentivizing cotton recycling, funding for international exchange, research, and innovation on fibre to fibre recycling Municipal: selective collection of cotton textile waste, incentives for recycling and use of recycled material, support to local recycling businesses and technical trainings
Potential climate adaptation impact	Reduction in the consumption of water needed for cotton growing decreases vulnerability to climate change induced water scarcity Cotton fields might be cleared for food production in areas threatened by climate change induced food insecurity
Co-benefits	Creates a market for the separate collection of cotton textile waste Creation of employment and expertise in cotton recycling
Potential indicators	Mass of recycled cotton in garments compared to total mass of cotton in garments Amount of recycled cotton, e.g. in thousands m^3
Assumptions and preconditions	Relevant domestic textile production industry using cotton exists. Advanced fibre to fibre technology and the technical capacities for operating them are available. Garments are made of unblended clean cotton, susceptible to be treated at end of life by fibre-to-fibre recycling technology. Sorting capacities are sufficiently developed to supply the required input cotton. Market demand for fibre-to-fibre recycled textiles with comparable quality exists.
Time schedule	Medium to long: Installation, maintenance and sustainable operation of equipment, employee trainings and education
Proposed steps to determine GHG emission impacts and Emission Factors	1. Define GHG emissions per tonne of virgin cotton fibre (including from cotton cultivation using fertilizers and energy use in cultivation and production) 2. Determine share of recycled fibres in total cotton content of garments under a baseline scenario and one with the implementation of fibre-to-fibre recycling 3. Add potential GHG emissions from fibre-to-fibre recycling including energy use 4. Estimate the total consumption of cotton fibres 5. Calculate GHG emission reductions GHG emissions savings = (Total consumption of cotton fibres) × [(GHG emissions per tonne of virgin cotton fibre) – (GHG emissions per tonne of recycled fibre)] × [(Share of recycled fibres in implementation scenario) – (Share of recycled fibres in baseline scenario)]
IPCC Guidelines volumes, chapters, and worksheets, links to EFDB	Volume 2: Energy: Chapter 2 Stationary Combustion, worksheet 1A Fuel Combustion Activities, 1A4c Agriculture/Forestry/Fishing/Fish Farms Volume 3: IPPU: worksheet 2B1 Ammonia Production (for fertilizers) Volume 4: AFOLU: worksheets 3C3 Urea Fertilization, 3C4 Direct N_2O Emissions from Managed Soils, 3C5 Indirect N_2O Emissions from Managed Soils, 3C6 Indirect N_2O Emissions from Manure Management
Data needs	GHG emissions per tonne of virgin cotton fibre and per tonne of recycled fibre Total amount of production and consumption of cotton fibres
Further guidance, research, and tools	n/a
Covered in NDCs	Not found

WAS1: Organic waste composting	
CE category	6.2 Increase share of secondary materials
Product group	Food and feed products
Context	Organic waste, including food and agricultural waste can be a major source of GHG emissions, if improperly treated. Estimates suggest that the waste sector is responsible for almost 20% of anthropogenic methane emissions. Methane emissions occur if organic waste decomposes under anaerobic conditions, which might be the case in landfills, improperly operated composting facilities and unmanaged waste disposal sites. Appropriate composting of organic waste both at a decentralized community level and at industrial level facilitates aerobic decomposition of organic waste. In addition, application of compost can improve the soil's ability to sequester carbon.
Instruments for implementation	National: policies and regulations on organic waste management, including separate collection, food loss and waste, and agricultural waste; improve framework conditions for a market for products made from compost, such as organic fertilizer Local: improve awareness and technical capacities for separating organic waste, composting, support composting activities and the local use of output products
Potential climate adaptation impact	Appropriate application of compost can enhance soil health by reintroducing nutrients to the soil and improving its water-holding capacity. The improved water retention can enhance soil resilience to climate change induced floods and droughts.
Co-benefits	Reduced risk of leachate in landfills Employment in composting, however jobs in waste landfilling might decrease Reduced dependency on synthetic fertilizer supply
Potential indicators	Estimated share or amount of organic waste composted
Assumptions and preconditions	Organic waste is collected separately (e.g. at households, farms, and restaurants) and complies with minimum quality standards. Communities are technically prepared and willing to adopt composting practices. Industrial composting facilities are operated and maintained correctly and efficiently process the separated organic waste. Composting monitoring and reporting system is in place.
Time schedule	Medium: sustainable installation and operation of systems at community and centralized levels, acceptance for composting and using output products
Proposed steps to determine GHG emission impacts and Emission Factors	1. Estimate composition of organic waste for diversion from landfilling to composting, considering e.g. food waste, agricultural waste and garden waste 2. Estimate GHG emissions from one tonne of organic waste degradation in landfilling 3. Estimate GHG emissions from composting one tonne of organic waste, considering the fossil fuel use for transport and operation and waste degradation 4. Determine amount of organic waste to be composted 5. Estimate avoided GHG emission by replacing chemical fertilizer with organic fertilizer from compost, if applicable 6. Calculate GHG emission reductions CO_2 emissions from composting have biogenic origin and are not taken into account. Emission factors depend on local conditions, such as climate, composition of organic waste, composting method and others. Regional default data on composting is provided in IPCC guidelines Volume 5, chapter 2, Table 2.1 (see below)
IPCC Guidelines volumes, chapters and worksheets	Volume 5: Waste: Chapter 2 Waste Generation, Composition Management Data (Table 2.1), Chapter 4 Biological Treatment of Solid Waste (e.g. equations 4.1 and 4.2) and worksheet 4B
Data needs	Material flow analysis of waste streams, e.g. organic kitchen, plant/garden, food and feed industry waste, livestock manure and current treatment systems Data or estimates on expected future treatment of these waste streams in composting following proposed policies
Further guidance, research, and tools	IPCC Waste Model GIZ Solid Waste Management Calculator
Covered in NDCs	Côte d'Ivoire, Ecuador, Eritrea, Ethiopia, Liberia, Namibia, Sudan, and others

WAS2: Anaerobic digestion including biogas generation

CE category	6.2 Increase share of secondary materials
Product group	Food and feed products Durable plant-based (biotic) products (e.g. paper, cardboard packaging)
Context	Estimates suggest that the waste sector is responsible for almost 20% of anthropogenic methane emissions. Organic waste treatment in controlled anaerobic digestion processes avoids CH_4 emissions from organic waste degradation in landfills. The production of biogas can partly replace fossil energy sources and their CO_2 emissions. Also, the production of organic fertilizer from digestate can reduce the need for artificial fertilizer production and respective emissions. It is essential to continually monitor methane slippage at biogas facilities to avoid emissions.
Instruments for implementation	National: introduce or extend organic waste separation for example at households, restaurants or farms; develop and adopt safety and environmental regulations and standards on anaerobic digestion, including to prevent fugitive emissions/leakage Local: separate waste collection; plan, build, operate and monitor treatment facilities and biogas production; training on sound operation avoiding methane slippage.
Potential climate adaptation impact	Reduction of unsafe landfilling including organic waste may decrease leachate, protecting groundwater resources and reduce vulnerability to water scarcity.
Co-benefits	Creation of jobs in anaerobic digestion and potentially biogas and fertilizer production Reduced dependence on fossil energy sources and synthetic fertilizer
Potential indicators	Percentage of organic waste processed in anaerobic digestion Production of biogas and organic fertilizer
Assumptions and preconditions	Organic waste is collected separately or separated and complies with standards. Methane fugitive emission detection and regular leakage tests of installations and pipelines are properly and continually implemented. Technical skills and capacities are available to operate complex biogas systems If nutrients are recovered, standards for digestate treatment, including drying and concentration, and regulations for the application of digestate are implemented. Regulatory authorities and waste management operators are aware of the risks and preconditions for environmentally sound management of anaerobic digestion.
Time schedule	Long: Transformation to sustainable operation and upscaling of anaerobic digestors
Proposed steps to determine GHG emission impacts and Emission Factors	1. Estimate composition of organic waste for diversion from landfilling to anaerobic digestion, considering e.g. food waste, agricultural waste and garden waste 2. Estimate GHG emissions from one tonne organic waste degradation in landfills 3. Estimate GHG emissions from anaerobic digestion of one tonne of organic waste, considering energy for transport and operation and unavoidable leakage 4. Determine amount of organic waste to be diverted to anaerobic digestion 5. Estimate avoided GHG emission by replacing fossil energy sources with biogas and by replacing artificial fertilizer, if applicable 6. Calculate GHG emission reductions For the baseline scenario emission factor (solid waste disposal), see e.g. ID 62639 in the emission factor database: CH_4 emission factor for managed municipal solid waste disposal (US) = 2 kg CH_4/capita/year
IPCC Guidelines volumes, chapters, and worksheets	Volume 2: Energy: Chapter 2 Waste Generation (for fossil fuel consumption) Volume 5: Waste: Chapter 3 Solid Waste Disposal, A1.3 and A1.4; Chapter 4 Biological Treatment of Solid Waste (for anaerobic digestion)
Data needs	Material flow analysis of waste streams, e.g. organic kitchen, plant/garden, food and feed industry waste, livestock manure and current treatment systems Data or estimates on expected future treatment in anaerobic digestors; Material flow analysis of present fertilizer use, possibly analysis of nutrient cycles; Feasibility studies and estimates of expected biogas use
Further guidance, research, and tools	IPCC Waste Model GIZ Solid Waste Management Calculator Teichmann, D., Schempp, C. (2013): Calculation of GHG Emissions in Waste and Waste-to-Energy Projects, JASPERS working papers
Covered in NDCs	Cambodia, Viet Nam

WAS3: Diverting waste from landfilling to recycling to avoid pollution (adaptation)	
CE category	6.2 Increase share of secondary materials
Product group	Mineral-based (a-biotic) products (e.g. buildings, cars, domestic appliances) Durable plant-based (biotic) products (e.g. paper, cardboard packaging) Food and feed products
Context	Landfills can pollute natural resources (soils, groundwater, air) in their surrounding area. In areas where climate change evokes more intense and frequent extreme weather events, such as intense rain or storms, their impacts might overwhelm environmental protection measures in landfills, polluting nearby resources. If less waste is landfilled and instead recycled, the amount of pollution can be respectively reduced, when it comes to hazardous waste such as batteries, biomedical waste but also household and commercial organic waste.
Instruments for implementation	National or regional policies concerning waste management regulations including waste separation at the source or segregation, phase out landfilling at the national level and provide support for recycling alternatives Regional and local governance regarding industrial and local waste management policies and implementation (e.g., public procurement of waste sorting collection and recycling services), plan, build and operate recycling facilities such as composting
Potential GHG mitigation impact	Reduction in the GHG emissions from production of virgin materials (whether biotic or abiotic) replaced by recycled materials or by avoiding emissions from solid waste disposal or incineration, see also sheets WAS1 and WAS2
Co-benefits	Creation of employment in recycling processes
Potential indicators	Volume or weight of recyclable materials collected and processed compared to total waste generated Volume or weight of waste sent to landfills
Assumptions and preconditions	Communities, public and private actors adopt waste separation practices. Waste is separated to an extent allowing the recycling of individual material streams. Recycling systems efficiently process separated waste.
Time schedule	Medium: national, regional, and municipal level policy and infrastructure development
Description of Climate Risk	Climate Hazard: Extreme weather events like storms or heavy rainfalls which generate floods and might cause water and soil pollution because of landfill leachate Exposure: Areas surrounding landfills, including surface and groundwater bodies, agricultural soils, and ecosystems Vulnerability: Natural resources and their users (such as farmers and water consumers) sensitive to contamination → Diversion of waste reduces the risk of pollution for communities and ecosystems
Data needs	Pollution/quality of natural resources impacted by landfill, such as surface water, groundwater, air, and soils Material flow analysis of waste streams
Further guidance, research, and tools	None
Covered in NDCs	Dominica (Kalinago Zero Waste Community Project), Liberia (diversion of organic waste to prevent landfill fire outbursts),

WAT1: Wastewater reuse, including the recovery of nutrients (adaptation)	
CE category	6.2 Increase share of secondary materials
Product group	Water
Context	The treatment and reuse of wastewater can contribute to both adaptation and GHG mitigation targets. Reuse of treated wastewater, for instance for irrigation can provide an alternative water resource in areas threatened by climate change induced water scarcity and contribute to preserve freshwater or use it for human consumption.
Instruments for implementation	National: Develop or update standards and regulations and policies concerning wastewater reuse, for instance minimum standards for irrigation water quality Local: Trainings and capacity enhancement in wastewater treatment operation; raising awareness for the usability of treated wastewater
Potential GHG mitigation impact	GHG emissions from wastewater, in particular methane and nitrous oxide can be reduced through proper wastewater and sewage sludge treatment with the potential to produce and use biogas as an alternative source of energy. See IPCC emission guidelines Volume 5, Waste: Wastewater Treatment and Discharge (Ch. 6), 2006 source category: 4D In addition, the production of nitrogen and other nutrients can be reduced if these are recovered from wastewater.
Co-benefits	Reduced dependence on market for nutrients such as nitrogen, phosphorus, and potassium, if these are recovered from wastewater and used locally Environmental protection, as amount of untreated wastewater decreases
Potential indicators	Share of treated wastewater used for agricultural irrigation, sanitary purposes (e.g. toilet flushing) or as drinking water Amount of wastewater treated and reused (e.g. in million cubic meter) Amount of nutrients recovered from wastewater
Assumptions and preconditions	Communities and farmers accept treated wastewater for irrigation. Wastewater treatment plants are sustainably operated and maintained, complying with international standards for operation safety and water quality. Regulatory frameworks encourage the use of treated wastewater for irrigation, for instance through financial incentives.
Time schedule	Long: Construction or refurbishment of wastewater treatment facilities and their sustainable operation and maintenance
Description of Climate Risk	Climate Hazard: Changes in precipitation patterns and increased temperatures generating water scarcity. Exposure: Communities, agricultural lands and/or ecosystems located in areas affected by water scarcity. Vulnerability: Domestic, agricultural, and industrial users depending on the available water resources. → Providing an alternative source of water, treated wastewater can reduce the vulnerability to water scarcity.
Data needs	Water demand and use by domestic, agricultural, and industrial sectors Amount and composition of wastewater produced in industry and households
Further guidance, research, and tools	Alliance for Global Water Adaptation (AGWA): Water Resilience Tracker for National Climate Planning World Resources Institute (WRI) (2017): Rethinking Wastewater Can Help Achieve Both Climate and Development Goals Energy Performance and Carbon Emissions Assessment and Monitoring (ECAM) Tool (on GHG mitigation) IPCC AR 6: Climate Change 2022: Impacts, Adaptation and Vulnerability (WG2): Chapter 4 on water, e.g. textbox 4.5: Reduce, Remove, Reuse and Recycle (4Rs): Wastewater Reuse and Desalination as an Adaptation (p. 631).
Covered in NDCs	Colombia, Jordan, Morocco (on both mitigation and adaptation), Togo (in rural areas)

CRC1: Awareness campaigns on sustainable consumption	
CE category	7.1 Behavioural measures and awareness campaigns
Product group	Depends on the sector(s) of campaign focus, e.g. mineral-based (a-biotic) products, food, and feed products or durable plant-based (biotic) products
Context	Awareness campaigns can contribute to reduce the demand for new products, decreasing the need for production and generation of waste along with the respective GHG emissions. Outreach can target specific products or product groups, such as food or domestic appliances or consumption as a whole. Campaigns can also aim at additional circular goals, for instance improved waste management through sharing sustainable composting practices. GHG emissions reduction from improved awareness is difficult to comprehend and depends on the specific product groups targeted.
Instruments for implementation	National: Coordination at ministry level, financial support, set targets and indicators Regional and local: Campaign implementation adapted to local context, for instance through advertising, social media, local events, collaboration with businesses
Potential climate adaptation impact	Depending on specific topic; for instance, if a focus is on reducing food waste, resilience to climate change induced food insecurity can be improved. Improved awareness on circular GHG mitigation strategies can generally enhance preparedness for climate change and its impacts.
Co-benefits	Less landfilling if the campaign targets waste reduction Less pollution from production processes if campaign targets reduced consumption
Potential indicators	Number of social media posts or public events Number of persons reached (e.g. event attendance, social media impressions) Change in consumption patterns depending on specific focus
Assumptions and preconditions	Consumption behaviour pattern monitoring and analysis are in place. A large variety of stakeholders, including private sector, civil society, NGOs, and research institutions is included from the planning stage. Campaign objectives do not threaten income perspectives of vulnerable communities (for instance small farmers might suffer if a campaign aims at less food purchases).
Time schedule	Long: Sustainable behaviour change as a result of campaigns can only be expected in the long term
Proposed steps to determine GHG emission impacts and Emission Factors	Approaches, methods, and emission factors depend on targeted sector activities. In addition, measuring the impact on awareness campaigns on GHG emissions is challenging.
IPCC Guidelines volumes, chapters, and worksheets	
Data needs	Data/statistics on community consumption patterns, including from interviews about changes in behaviour
Further guidance, research, and tools	The Circular Way to Inclusion: Guidelines for Awareness Campaigns Related to Circular Economy
Covered in NDCs	Papua New Guinea (Community and Household Waste Awareness)

CRC2: Support for circular procurement in SMEs	
CE category	7.3 Finance and business support
Product group	Multiple, depending on the domain of the SMEs, for instance mineral-based (a-biotic) products, food and feed products and durable plant-based products
Context	In many countries, more than 90% of businesses are Small and Medium Enterprises (SMEs) with less than 250 employees (OECD definition), contributing with up to 70% to the global GDP. The circular transformation of SMEs is therefore crucial for achieving climate objectives. Procurement standards are a main lever for changing the resources and material use by private actors. Public authorities can give guidance or set criteria for procurement considering the principles of circularity and the waste hierarchy. New standards could for example increase the share of recycled content according to international norms and standards or applying circular criteria when selecting suppliers for a specific production type, reducing GHG emissions from raw material extraction and processing.
Instruments for implementation	National level: Development and introduction of guidelines and standards for procurement in SMEs, application of internationally recognized standards, balancing restrictive elements with incentives such as a certification scheme and financial support for early adopters, including transition stages Regional and local: Business support for SMEs adopting circular procurement, including trainings, exchange sessions and preparing good practice case studies together with leading SMEs
Potential climate adaptation impact	Depending on the specific mechanism, for instance, reduction of soil deterioration or water pollution generated by SMEs as a result of updated procurement standards could increase the climate resilience of persons, communities and ecosystems.
Co-benefits	Development of expertise and employment in climate sensitive circular business approaches Potentially improved opportunities to contribute to regional or international value chains following shared circularity and climate standards
Potential indicators	Share of SMEs or GDP covered by circular procurement standards Share of SMEs certified as early adopters of climate sensitive circular procurement Depending on economic sector with updated procurement standards, for instance share of recycled content, average product lifespan, use of non-renewable resources
Assumptions and preconditions	Changes in procurement towards climate sensitive circularity assume realistic economic conditions and constraints for SMEs without overstraining their competitiveness. Procurement standards are generally met by businesses. Continuous and effective monitoring and evaluation processes are in place.
Time schedule	Long: Implementation of new procurement guidelines; it is recommended to follow a gradual approach with transition periods depending on the preparedness of the SME economy
Proposed steps to determine GHG emission impacts and Emission Factors	Approaches, methods, and emission factor variables depend on sector and specific aspects targeted by the procurement standards.
IPCC Guidelines volumes, chapters, and worksheets	
Data needs	Regular data on number and size of SMEs and their resources, demand, and consumption
Further guidance, research, and tools	n/a
Covered in NDCs	South Sudan (procurement of cement, however no focus on SMEs)

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