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HOW TO DESIGN CIRCULAR ECONOMY PROJECTS: A STAP ADVISORY DOCUMENT

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STAP SCIENTIFIC AND TECHNICAL ADVISORY PANEL
An independent group of scientists that advises the Global Environment Facility

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Background

The Global Environment Facility (GEF) tackles the planet's most pressing environmental problems by supporting developing countries in fulfilling their obligations under multilateral environmental agreements to deliver global environment benefits (GEBs). A significant proportion of these problems stem from the linear material production and consumption model, which contributes to greenhouse gas emissions, biodiversity loss, land degradation, and chemical and water pollution.

The circular economy approach is an alternative to the linear "take, make, use, dispose" model; it seeks to keep resources in use for as long as possible, extract the maximum value from them while in use, and recover and regenerate products and materials at the end of their service life. In effect, the approach promotes a production and consumption model based on reuse and recycling of materials by design.[1]

A circular economy approach ensures that products, materials, and resources are maintained at the highest utility and value for as long as possible while minimising waste generation and the use of hazardous materials. It embraces systems thinking and innovation and seeks to ensure that stakeholders in the materials value chain can play a significant role in achieving more efficient use of resources.

The circular economy approach seeks a paradigm shift in how economies are structured. This requires a systems approach to developing projects. Simply considering end-of-life options such as "recycling" is not enough. Circularity requires the overall accounting of material and energy flows from cradle to cradle, for example, through the life cycle approach, and some GEF projects have used this approach.[2] And the GEF Impact Programs – in particular, Sustainable Cities, and Food Systems, Land Use, and Restoration – provide a significant opportunity to scale up a circular economy approach. The GEF is already implementing exemplary circular economy projects, including in the plastics and textiles sectors.[3]

The Scientific and Technical Advisory Panel (STAP) has produced three circular economy reports to date. The plastics report[4] showed how a circular approach could reduce plastic pollution and deliver benefits in many areas, such as biodiversity, chemicals and waste, climate change, international waters, and land degradation. The report on a future food system[5] highlighted the role of the circular economy in improving resource efficiency in food production and consumption and avoiding adverse impacts of the agrifood system on land, water, and climate. STAP's report on the circular economy and climate change mitigation[6] showed how a circular economy approach could support more ambitious climate action and deliver other local environmental and socioeconomic benefits. It presented 14 interventions in diverse economic sectors, with case studies illustrating successful implementation in different parts of the world. Together, these three reports provide a comprehensive scientific and technical underpinning for the circular economy approach.

This paper builds on these STAP reports to help the GEF plan, design, and implement future circular economy projects. STAP's paper *Enabling Elements for Good Project Design*[7] (see the Annex) provides a sound basis for good project design. This report applies these enabling elements to the design of circular economy projects.

Developing circular economy projects

The circular economy is a paradigm shift in the way resources are used in the economy. It reconfigures resource systems to conserve energy and material flow through cyclical processes that mimic ecosystems' natural cycles.[8]

A resource system typically comprises (i) components (e.g. materials and products from extraction, production, consumption, and disposal), which interact with one another, and (ii) actors that control how materials move within the system (e.g. manufacturers, retailers, the waste management industry, investors, government, civil society, consumers). The system components also interact outside the system, including with the environment, technologies, legislative and economic policies, markets, and sociocultural issues. For example, the environment is the source of natural resources and is affected by their extraction and processing, use, and disposal.

Government policies, regulations, and institutional frameworks influence how products and services are made and delivered. And sociocultural factors, human behaviour, and financial incentives play significant roles in consumption patterns and influence the demand and supply of resources.

To design an effective circular economy project, it's important to understand the components that form the resource system and how those components interact with one another and with external factors. With this understanding of system behaviour, projects can be developed to transform the resource system towards circularity. Figure 1 presents a step-by-step guide to the design of circular economy projects and summarises some specific questions and actions required at each stage.

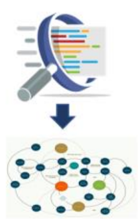
STEPS FOR CIRCULAR ECONOMY PROJECT DESIGN		
	**IDENTIFY THE PROBLEM**	What material processing activities are of interest? For example, food, plastics, textiles, electronics.
		What are the problems? For example, use of non-renewable resources, use of harmful chemicals, adverse impacts of production on ecosystems or the environment.
		Within what system boundaries are the problems occurring? For example, e-waste transported to third countries for recycling, food waste deposited in landfills.
	**ENGAGE STAKEHOLDERS**	Who are the relevant stakeholders? For example, manufacturers, retailers, the waste management industry, investors, government, civil society, consumers.
		What are their interests? For example, governments may seek to promote sustainable development, investors may prioritize profit over environmental gains, citizens may prefer traditional linear materials use over circular approaches.
		How are the stakeholders related to one another? For example, which stakeholders have the power to change, or resist, outcomes?
	**DECIDE ON THE OBJECTIVE**	How should the resource system function ideally (i.e. in a circular economy)? For example, harmful substances are avoided to enhance recyclability; business models support the return of products for reuse, repair, remanufacturing, and recycling; government provides an enabling environment to support circularity.
		In an ideal system, what outcomes and impacts are expected? For example, more efficient resource use, reduced greenhouse gas emissions and biodiversity loss, reduced harmful health effects, improved food security, better economic opportunities.
	**ANALYSE THE SYSTEM**	Use systems analysis tools to analyse the system. For example, life cycle analysis, material flow accounting, input–output analysis.
		What are the system's components and the interactions between them? For example, the food system comprises natural resources like soil and water and is influenced by technology, governance and policies, economics and market factors, and sociocultural factors (e.g. consumer behaviour).
		How do relevant stakeholders influence the system?
		Provide a narrative description of the system, ideally with diagrams. For example, systems map, causal loop diagram, concept map, problem diagram.
	**IDENTIFY LEVERAGE POINTS**	Identify leverage points where interventions can lead to significant system change.
		Leverage points are usually connected to the major drivers of the problems. For example, electronics manufacturing is an important leverage point in e-waste management, and it is connected to important drivers such as demand, planned obsolescence, and natural resources (see Box 1).
	**DEVELOP INTERVENTIONS**	Engage stakeholders in developing interventions, explaining the rationale, and making clear on what assumptions each of the interventions is based.
		Support bio-based solutions that promote regenerative resources over non-regenerative. For example, agroecology over conventional farming solutions; plastics from bio-based sources over improvement of fossil fuel-based plastics production.
		Consider STAP's enabling elements (see the Annex). In particular, incorporate innovation (e.g. technology, finance, business model, institutional change) and explicitly address the need for behavioural change.
		Seek integrated solutions that can deliver multiple global environmental benefits. Consider whether there are opportunities for scaling and transformational change.
	**IDENTIFY AND SELECT METRICS AND INDICATORS**	Use the GEF's results framework to identify relevant indicators to assess global environmental benefits.
		Consider appropriate metrics for local environmental and socioeconomic co-benefits. For example, reduced air and water pollution, more efficient use of resource (increased recycling rate), increased crop yield, job creation.
	**IMPLEMENT, MONITOR, EVALUATE, LEARN AND ADAPT**	Monitor and evaluate to determine whether the project is on track to achieve the intended outcomes.
		Learn from monitoring and evaluation and adapt the intervention, as necessary.
		Use the knowledge gained to increase impact and to achieve scaling and transformation.

Figure 1. Summary of the step-by-step guide to developing a circular economy project

1. Identify the problem

As the first step in circular economy project design, identify the resource problem and the system in which it is embedded. A typical resource system is complex, with several components and more than one problem arising from the unsustainable use of resources. For example, problems with linear agricultural production include how crops are produced (e.g. conventional agriculture versus agroecology), where they are produced, the values of the producers (e.g. prioritising crop yield over crop yield, soil health, *and* biodiversity conservation), and consumer behaviour. Problems with product packaging may include the type of materials (e.g. use of plastics instead of more environmentally friendly options), the use of toxic chemicals in plastic production (which makes it non-recyclable and harmful to human beings and the environment), energy use in the production process (with consequent greenhouse gas emissions), and the lack of collection and recycling facilities (leading to water pollution, including terrestrial and marine litter). STAP's earlier reports on the circular economy[9] highlight several resource systems – including food and agriculture, construction, textiles, transportation, building, electronics, and plastics – and discuss some of the challenges involved in the transition to a more circular economy.

In this step, also identify the actors in the resource system and the relevant boundaries of the system. These boundaries could be resource-specific (i.e. the type of materials, products, energy, chemicals, or substances of interest); spatially specific (i.e. the place where the resources are made or used – for example, a city, country, geographic region, ecosystem, or factory); or process-specific (i.e. how resources are processed to make products and services – for example, manufacturing process, agricultural production, construction process, transportation infrastructure, energy production process, or service delivery method).[10]

2. Engage stakeholders

Once the problem and the system in which it is embedded have been identified, determine the relevant stakeholders who need to be engaged in the project to provide their varied perspectives.[11] Different stakeholders understand the same resource system differently. For example, garment manufacturers and investors are likely to have different views on textiles and clothes than policymakers or cotton farmers. However, all have important contributions to make.

At this stage, project developers should ensure that key stakeholders have been identified and engaged. For example, involving retailers and suppliers to address production and supply priorities and prevent wastage, and collaborating with the food supply chain to standardise labelling and provide accurate information on food to consumers, is likely to lead to more effective outcomes. STAP's advisory document on multi-stakeholder dialogue sets out some principles and practices that can contribute to effective stakeholder engagement.[12] Tools such as social network analysis[13] can also help in analysing stakeholder roles and influence.

3. Decide on the objective

Articulate the project's objective in a statement that captures the problem and the desired solution(s); the statement should explain the project's expected outcomes and intended impacts. For example, the objective could be to facilitate the transition from traditional, high-input agriculture to circular agriculture by promoting regenerative agricultural practices and deploying a new business model that improves soil health, biodiversity, carbon mitigation, crop yield, and food security. From a circular economy perspective, the goal is to change the resource system so that the materials used in the system are returned to productive uses at the end of their original life (a "cradle to cradle" life cycle). Deciding on the overall objectives is part of developing a theory of change (refer to STAP's *Theory of Change Primer*[14]), which should be revisited and elaborated as the project is developed further.

4. Analyse the system

Project designers need to understand how the system functions as a whole, not simply as a collection of individual parts operating in isolation. Carry out a system analysis to gain understanding of the interactions between system components and how they relate to the problem identified in Step 1. The analysis should examine positive and negative feedback mechanisms and cause-and-effect relationships that influence the system's structure and behaviour to highlight the most important system components and how relevant stakeholders influence the system.

The system analysis includes engaging stakeholders (Step 2) to examine the causes of the problem and helps identify leverage points, where interventions can be focused to have the greatest effect on the system (Step 5). For example, reducing the use of harmful synthetic dyes in the fabric industry by substituting bio-based dyes would include looking at the supply chain of chemical dyes and their environmental effects – from production through to end of use. The system analysis will help in developing the project's theory of change and in identifying interventions (Step 6) that can realise the project's objective.

Life cycle assessment[15] is often useful in systems analysis: it identifies impact variables that can be measured for any product within the system's full "cradle to grave" life. This is an important project planning tool and is also useful for monitoring and learning. Other systems analysis tools that may be useful include material flow accounting,[16] environmental footprint analysis,[17] and environmental input–output analysis.[18] Preparing a detailed narrative text and diagram of a system can also be helpful. Examples include concept or system mapping, problem maps, causal loop diagrams, and influence diagrams. Box 1 gives an example of a system diagram for the management of e-waste.

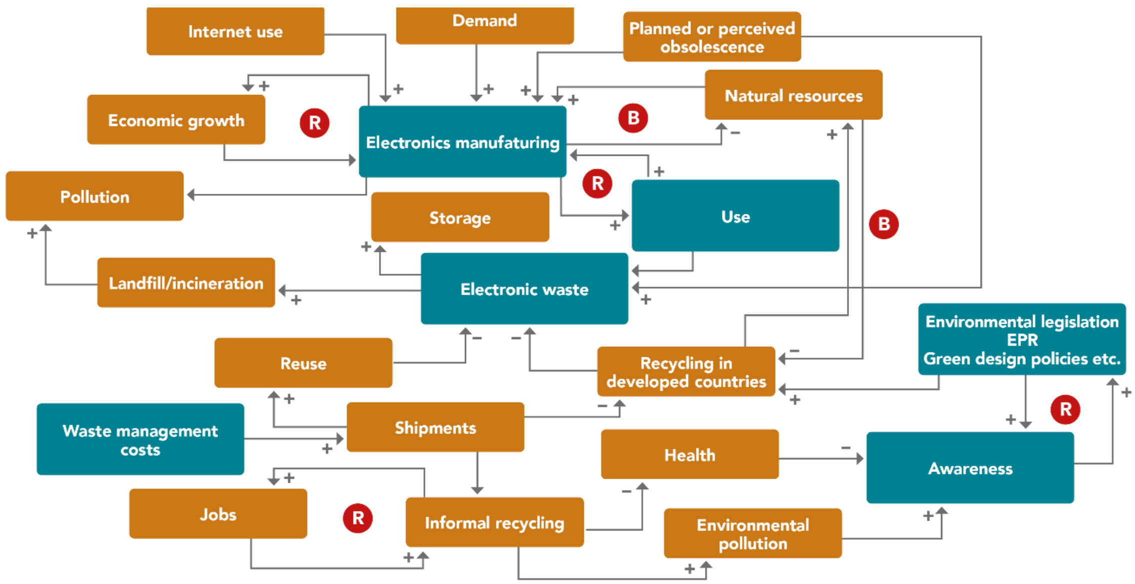
5. Identify leverage points

Using the detailed understanding of the system gained through the system analysis, identify the leverage points,[19] where interventions can best be made to change the system. Effective leverage points:

- Are root causes of the problem the project aims to solve
- Influence several other system components
- Have multiple effects within the system
- Can be altered or modified within the scope and influence of the project

For example, in the system analysis diagram in Box 1, electronics manufacturing is an important leverage point in managing e-waste. Demand, planned or perceived obsolescence, natural resources, Internet use, and economic growth are major system drivers that influence electronics manufacturing, leading to increased use of electronics and the generation of e-waste. Projects that aim to mitigate the environmental impacts of e-waste, therefore, need to address these drivers, and identify the key leverage points, for example through behavioural change to reduce demand for electronics, policies to tackle planned obsolescence (e.g. redesigning electronics for longer life), and incentives to encourage the sustainable use of natural resources.

Box 1: Causal loop diagram – example of a system diagram[20]



This causal loop diagram of global e-waste management shows the causes and effects, and feedback loops within the system. The positive and negative signs represent the directions of cause and effect (positive signs show the effect being enhanced; negative signs show it being reduced). The red Rs indicate a reinforcing system, in which two system components strengthen each other and influence system behaviour in a specific direction (e.g. higher demand for electronics increases manufacturing and demand for base materials). The red Bs indicate a balancing or stabilising process, in which one system component limits the growth of another (e.g. electronics manufacturing uses natural resources and negatively affects ecosystem services which may limit production). Note: EPR is "extended producer responsibility".

Demand, planned or perceived obsolescence, natural resources, Internet use, and economic growth are the major drivers of electronics manufacturing and, consequently, e-waste. The cost of environmentally sound waste management is the primary driver of transboundary shipments of e-waste. Shipments to developing countries may create jobs but may also have adverse effects on human health and cause environmental degradation.

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6. Develop interventions

Develop a suite of possible interventions that can act on the identified leverage points to meet the project's objective. The theory of change should include causal pathways for planned interventions, and explicitly identify underlying assumptions, including enablers of, and barriers to, success.

Well-designed interventions will capitalise on opportunities for innovation, integration, scaling up, transformational change, and durability to future change. As noted in the STAP *Enabling Elements* paper (see the Annex), projects should look for durable impact, employ innovative interventions (e.g. technological, financial, policy, or business model), and address behavioural change where needed.
Examples include the following:

- Alternative uses for unwanted food or crop residue, such as reprocessing into other foods or functional materials, have been developed in numerous projects (e.g. bread to biscuits,[21] food waste to animal feed,[22] root vegetable fibre to concrete,[23] banana stalk fibre to paper, and paper bags,[24] pineapple leaves to leather[25]).
- A pay-as-you-store circular business model was introduced in Nigeria to provide modular, solar-powered walk-in cold rooms that allow farmers to access storage facilities to preserve their produce at an affordable price.[26]
- Innovative digital technology platforms, such as the Tekeya,[27] Flashfood,[28] and Olio[29] apps, have been used to connect consumers and charities to households, hotels, restaurants, groceries, bakeries, and other food retailers willing to donate or sell (at a reduced price) their surplus or close-to-expiry food. This has reduced food waste and is changing consumers' attitudes towards accepting these types of food.
- To reduce waste and greenhouse gas emissions in procuring furniture for public buildings in Malmö, Sweden required behavioural change that involved creating awareness, encouraging local knowledge and capacity, and getting both individual and producer buy-in.[30]

The interventions should pursue integrated outcomes that maximise GEBs, deliver local environmental (i.e. non-global) and socioeconomic co-benefits, and avoid harmful and unintended consequences. For example, construction projects that incorporate diverse activities (e.g. use of modular and passive building design, concrete and bio-based alternatives, digital technologies for resource management and material efficiency, and use of construction waste as a resource) are more likely to deliver multiple benefits, such as reduced water pollution, land degradation, and biodiversity loss; better resource efficiency; reduced use of harmful chemicals; and improved health and safety during construction activities. Designing buildings and other infrastructure to be less material intensive, such as green roofs, bio-composites, or bamboo for structural material, natural ventilation, efficient water use, may yield more co-benefits than traditional construction methods. Similarly, plastics from bio-based sources such as sugarcane, oils and cellulose, sewage sludge, food waste, and naturally occurring polymers should be promoted rather than seeking to improve the production of plastics based on fossil fuels.

Project designers should identify potential co-benefits (refer to the Annex, point 6). For example, bio-based solutions that promote regenerative resources as an alternative to non-regenerative feedstock would reduce pollution and promote sustainable landscapes. Regenerative agricultural practices such as agroecology (which allows more species and nutrients to be maintained in the system than in traditional agricultural approaches) or soil enrichment through manure application would yield more co-benefits than techniques such as excessive soil tilling and chemical applications.

The interventions should be designed to yield durable GEBs and outcomes in a range of possible futures. Interventions that can be scaled and move a system towards transformative change should be favoured. For example, the proposed GEF-8 Circular Solutions to Plastic Pollution Integrated Program intends to involve the entire plastics sector and use circular economy principles to harness GEBs and transform the system.[31]

Project designers should engage relevant stakeholders in designing interventions, in addition to when analysing the problem. In the e-mobility sector, for example, it would be wise to engage stakeholders in the mining industry (whose income might decline due to greater circularity), manufacturers (to produce designs for longevity and ease of disassembly and reuse), businesses and consumers (to get buy-in for new business models that improve resource efficiency and service delivery), and governments (to create the necessary enabling environment).

Regulatory and policy changes that can help create an enabling environment for the circular economy may be an essential component of a successful circular economy project. Figure 2 provides an overview of potential policy instruments affecting circularity throughout product life cycles.

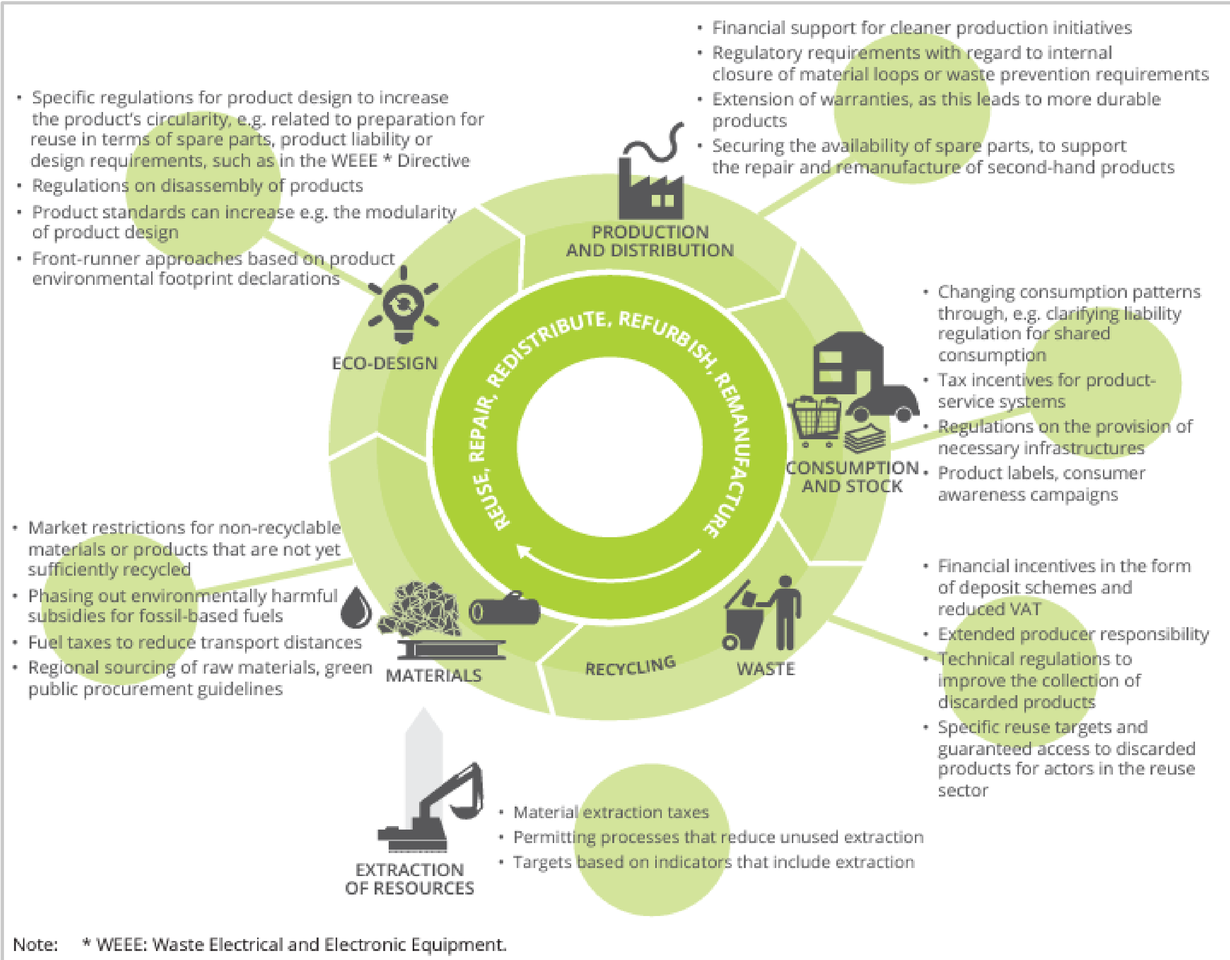

Figure 2: Overview of potential policies (legislative and economic) that could affect the circularity of products during different life cycle phases. Source: EEA, 2017.[32] These examples may not apply to all GEF projects. Some of the examples may only apply at the national level (e.g. phasing out environmentally harmful fossil fuel subsidies).

7. Identify and select metrics and indicators

Well-structured monitoring, evaluation, and learning frameworks are essential to assessing whether interventions are on track to achieve the project's expected outcomes, or if adaptive management is required. Determine which metrics and indicators should be adopted to assess progress.

Circular economy interventions are usually intertwined with socioeconomic co-benefits – for example, job creation, food security, energy access, and human health – for which indicators would also be useful. Impacts from projects can be measured using tools such as social impact assessment,[33] health impact assessment,[34] and full-cost accounting.[35]

8. Implement, monitor, evaluate, learn and adapt

Lessons from monitoring and evaluation should be used to re-evaluate understanding of the resource system. This improved understanding could necessitate the adjustment of interventions to achieve the desired outcomes and impacts, i.e. adaptive management.

Incorporate knowledge management and dissemination to ensure that lessons learned reach other relevant actors and entities who could benefit from these lessons. Seek to coordinate and integrate with existing knowledge exchange programmes or create new ones as needed.

South-South knowledge exchange initiatives could be a good vehicle for the dissemination and transfer of solutions.[36] The GEF has considerable experience with South–South knowledge exchange, including the South-South Community Innovation Exchange Platform, part of the Small Grants Program;[37] the International Waters Learning Exchange and Resource Network (IW:LEARN);[38] the Global Platform for Sustainable Cities,[39] developed by the Sustainable Cities Integrated Approach Pilot; and the UrbanShift Platform,[40] developed by the Sustainable Cities Impact Program.

Annex: STAP's enabling elements to achieve durable benefits

STAP's enabling elements for good project design are founded on a systems thinking approach, as illustrated in Figure A.1.

GEB = global environmental benefit; MEL = monitoring, evaluation and learning.

Figure A.1: Eight enabling elements to maximise enduring GEBs from GEF investments.

A review of STAP's past advice to the GEF highlights eight key, interlinked "enabling elements" that make investments more efficient and effective. Systems thinking and the use of a theory of change (#1) underpin all areas of project design. Applying the GEF's funding efficiently to achieve as much as possible with the resources invested means taking an integrated approach that delivers multiple benefits (#6) and engaging funding stakeholders (#2) to co-finance more outcomes and build ownership. Ensuring that GEF investments are effective means that achieved benefits should be durable in the face of future change (#3). Ongoing stakeholder support (#2) is essential to realise this and necessary for scaling outcomes to achieve real transformation (#7). These steps, in turn, demand innovation (#5) to provide better solutions, consideration of what incentives will drive behavioural change (#4) in stakeholders, as well as effective learning through knowledge management (#8) to adapt to changing circumstances (#3) and provide evidence to stakeholders (#2). Each enabling element is elaborated further in Table A.1.

Table A.1: STAP's eight key enabling elements (key papers referenced in the footnotes below)

1. **Apply systems thinking approaches and theory of change:** Apply systems thinking to create a rich understanding of **how the system functions**[i] and hence to create a **theory of change**[ii] that explains how a set of proposed actions will logically lead to enduring global environmental benefits (GEBs), given certain explicit assumptions.
2. **Engage the right stakeholders:** Develop **multi-stakeholder engagement**[iii] from inception and design through to project completion and beyond, through a stakeholder analysis early in design, considering **power dynamics,** the need for **behavioural change**,[iv,v] and the incentives and multi-stakeholder platforms needed to support such change.
3. **Ensure robustness to future change:** Scope possible changes[vi] in key systems drivers, **including climate change**,[vii] to ensure proposed interventions will (i) deliver a resilient response in the face of uncertain futures by applying simple future scenarios, and (ii) be **implemented adaptively**[viii,ix] when monitored assumptions of the **theory of change**[x] are not met.
4. **Be explicit about behavioural change:** Recognize that most significant interventions, especially if **transformational**,[xi] involve changes in **behaviour**,[xii,xiii] in distributional outcomes, and in **power dynamics**[xiv,xv] and address these explicitly in project design and implementation rather than leaving them tacit.
5. **Invest in innovation:** Take calibrated risks to drive rapid and appropriate **technological** development, new **financing** and **business** models, and significant **policy** and **institutional** changes within a portfolio strategy for diversifying risk and **innovation**[xvi,xvii] that emphasizes value creation and GEB outcomes.
6. **Pursue integrated outcomes:** Explore interactions among GEB areas to (i) achieve **multiple environmental outcomes**,[xviii] where possible, that maximize synergies and minimize trade-offs among the benefits and (ii) deliver other environmental and socioeconomic co-benefits where these are necessary to engage **stakeholder support** (prerequisite co-benefits) or can be achieved without distracting from the core GEBs (incidental co-benefits).
7. **Scale for systems transformation:** Be clear about where incremental as opposed to **transformational change**[xix] is intended, and analyse the barriers and opportunities for scaling towards transformative outcomes, developing a **theory of change**[xx] for the process of **scaling**[xxi] that applies relevant **innovations**.[xxii]
8. **Support learning with knowledge management:** Develop explicit plans and funding for good quality **knowledge management**,[xxiii] including enduring databases and useful common indicators, applying **monitoring, evaluation, and**

[i] O'Connell, D., et al. 2016. *Designing projects in a rapidly changing world: guidelines for embedding resilience, adaptation and transformation into sustainable development projects (Version 1.0)*. Scientific and Technical Advisory Panel to the Global Environment Facility, Washington, D.C.
[ii] Stafford Smith, M. 2020. *Theory of change primer*. Scientific and Technical Advisory Panel to the Global Environment Facility. Washington, D.C.
[iii] Ratner, B.D., and Stafford Smith, M. 2020. *Multi-stakeholder dialogue for transformational change*. Scientific and Technical Advisory Panel to the Global Environment Facility. Washington, D.C.
[iv] Metternicht, G., Carr, E., and Stafford Smith, M. 2020. *Why behavioral change matters to the GEF and what to do about it*. Scientific and Technical Advisory Panel to the Global Environment Facility. Washington, D.C.
[v] O'Donnell, T., and Laubenstein, T. 2021. *Insights into how social and behavioural sciences can influence project outcomes*. Australian Academy of Science. Canberra
[vi] STAP. 2021. *Making GEF investment resilient*. Scientific and Technical Advisory Panel to the Global Environment Facility. Washington, D.C.
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[xvi] Toth, F. 2018. *Innovation and the GEF*. Scientific and Technical Advisory Panel to the Global Environment Facility, Washington, D.C.
[xvii] STAP. 2021. *Achieving transformation through GEF investments*. Scientific and Technical Advisory Panel to the Global Environment Facility, Washington, D.C.
[xviii] Katima, J., and Leonard, S. 2020. *Delivering multiple benefits through the sound management of chemicals and waste*. Scientific and Technical Advisory Panel to the Global Environment Facility. Washington, D.C.
[xix] STAP. 2021. *Achieving transformation through GEF investments*. Scientific and Technical Advisory Panel to the Global Environment Facility, Washington, D.C.
[xx] Stafford Smith, M. 2020. *Theory of change primer*. Scientific and Technical Advisory Panel to the Global Environment Facility. Washington, D.C.
[xxi] The GEF Independent Evaluation Office elaborates "enabling conditions" for scaling, see p.109 in Batra, G., Uitto, J.I., and Feinstein, O. 2021. "Toward transformation change" in *Environmental evaluation and global development institutions: a case study of the Global Environment Facility*. Routledge. London. https://doi.org/10.4324/9781003207979.
[xxii] Toth, F. 2018. *Innovation and the GEF*. Scientific and Technical Advisory Panel to the Global Environment Facility, Washington, D.C
[xxiii] Stocking, M., et al. 2018. *Managing knowledge for a sustainable global future*. Scientific and Technical Advisory Panel to the Global Environment Facility. Washington, D.C.

learning[xxiv,xxv] so the knowledge systems gather lessons learned, allow **adaptive management**[xxvi,xxvii] to be applied, and contribute to **scaling** pathways. [xxviii,xxix]

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[1] Barra, R., Leonard, S.A. 2018. *Plastics and the circular economy*. Scientific and Technical Advisory Panel to the Global Environment Facility, Washington, D.C.

[2] Examples include: a project to address chemicals and waste in the textiles and garment sector in Ethiopia (GEF ID: 10683); an investment to promote global chemical management (GEF ID: 9771); an industry–urban symbiosis and green chemistry project to address persistent organic pollutants in Thailand (GEF ID: 9219); and a project to reduce the use of natural resources by breweries in the Russian Federation (GEF ID 5293).

[3] Examples include: a project to address chemicals and waste in the textiles and garment sector in Ethiopia (GEF ID 10683); a project to promote circular economy approaches in the textiles and garment sector in Lesotho, Madagascar and South Africa (GEF ID 10543); a project to reduce marine plastics in Latin America and Caribbean cities (GEF ID 10547); and a project to deal with plastics in Indonesia (GEF ID 10546).

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[11] Salvioni, D.M., Almici, A. 2020. "Circular economy and stakeholder engagement strategy". *Symphonya: Emerging Issues in Management*, https://ssrn.com/abstract=3716266

[12] The principles of effective multi-stakeholder engagement include critically assessing system context; building on existing processes and coalitions; addressing power dynamics; being flexible; embedding monitoring, evaluation and learning; and embracing long-term planning: Ratner, B.D., Stafford Smith, M. 2020. *Multi-stakeholder dialogue for transformational change*. Scientific and Technical Advisory Panel to the Global Environment Facility, Washington, D.C.

[13] Social network analysis is a method for analysing individuals, groups or social structures, and their interrelationships, to gain overall insights about a social network. It is used to identify how closely actors within a network are connected and which actors are more central or peripheral in a network and to map communication and information flows among those actors. It can be used for informing stakeholder engagement. See Scott, J., 2017. *Social network analysis*, 4th ed. Sage Publications, Thousand Oaks, CA.

[14] Stafford Smith, M., 2020. *Theory of change primer*. Scientific and Technical Advisory Panel to the Global Environment Facility, Washington, D.C.

[15] Refer to UNEP, "The Global LCA Data Access network", https://www.unep.org/explore-topics/resource-efficiency/what-we-do/life-cycle-initiative/global-lca-data-access-network**.** There are now several open source databases that enable life cycle analysis to be conducted with minimal cost. Refer to OpenLCA, "LCA data", https://www.openlca.org/lca-data**.**

[16] Material flow accounting provides an overview of natural resource extraction, waste disposal and emissions to highlight changes in material stocks within an economic system. See UNEP. 2021. *The use of natural resources in the economy: a global manual on economy wide material flow accounting*. United Nations Environment Programme, Nairobi, https://www.resourcepanel.org/news-events/unep-eurostat-irp-and-unsd-launch-global-manual-economy-wide-material-flow-accounting**.**

[17] Ecological footprint compares the rate at which resources are consumed and waste is generated against nature's ability to absorb the waste and regenerate resources. See Global Footprint Network, "Ecological footprint", https://www.footprintnetwork.org/our-work/ecological-footprint.

[18] Input–output analysis provides an overview of all inputs and outputs from a system. It provides insight into how materials are used by actors in a system. See Guilhoto, J.J.M. 2021. "Input–output models applied to environmental analysis". *Oxford Research Encyclopedia of Environmental*

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[25] Piñatex, https://www.ananas-anam.com.

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[34] Health impact assessment is a systematic approach for comprehensively assessing the potential health impacts on a human population, as well as the distribution of health impacts, arising from a project, programme, or policy. Health impact assessment considers health to mean physical, mental, and social well-being, and not just absence of disease. See, for example, WHO, "Health impact assessment", https://www.who.int/health-topics/health-impact-assessment.

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