International Resource Panel

UN environment programme

SCIENCE AS A COMPASS

GUIDING JUST AND RESILIENT RESOURCE TRANSITIONS FOR PEOPLE AND PLANET

2026-2029 WORK PROGRAMME

International Resource Panel

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I. Executive Summary

Executive Summary

2026-2029 Work Programme

Science as a Compass: Guiding Just and Resilient Resource Transitions for People and Planet

This summary provides an overview of aspects of the 2026-2029 Work Programme. It is submitted for Information to Panel and Steering Committee members. Please note that the full Draft Work Programme 2026-2029 (IRP.34.08.01) is submitted for input and recommendation by the Panel, and for approval by the IRP Steering Committee.

I. Background and process to date

As per paragraph 73(a) of the Policies and Procedures of the International Resource Panel (IRP), every four years, the IRP Secretariat carries out a Strategic Planning Exercise to develop the IRP Work Programme. Figure 1 reflects the process followed to date.

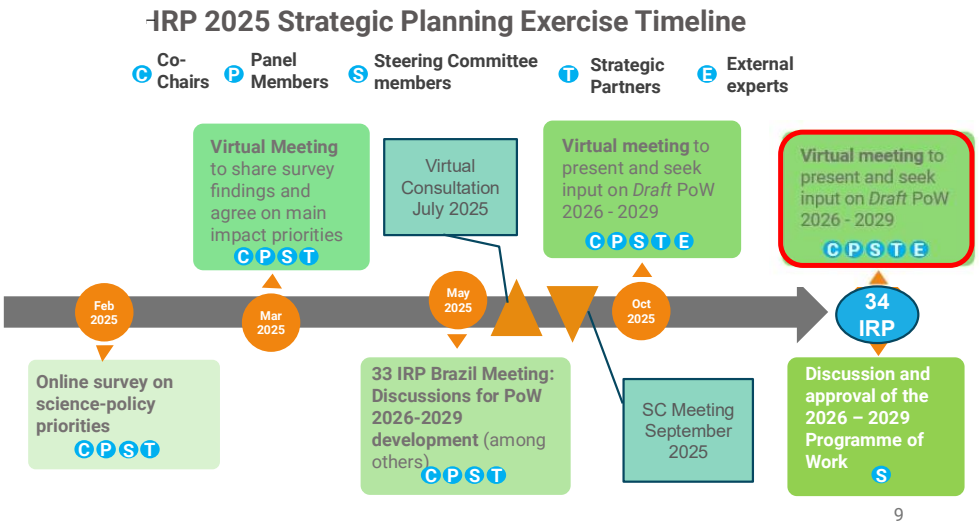


Figure 1: Strategic Planning Exercise 2025

The terms of the Strategic Planning Exercise were agreed at the 32nd meeting of the IRP (November 2024). An online survey circulated in February 2025 to gather input from Panel members, Steering Committee members, and Strategic Partners on key science-policy priorities, emerging issues, and the IRP's Theory of Change and current High-Impact Priority Areas (HIPAs). To complement and validate these survey findings, a virtual consultation was convened by the Secretariat in March 2025 to present the survey findings for feedback. These discussions were integrated into a background document prepared, with input from IRP Panel Members, and submitted for discussion at the 33rd meeting of the IRP in May 2025 (Sao Paulo).

At the 33rd meeting of the IRP, members were provided with the opportunity to identify work strategic priorities and provide feedback on a selection of research proposals that were developed by IRP Panel members. Following the IRP 33rd Meeting, the Secretariat was requested to:

> (1) consolidate confirmed and newly proposed research streams under each HIPA and assess each proposal based on the prioritization criteria identified by the Steering Committee at 33IRP (relevance, impact, expertise fit, feasibility, scientific rigor, and communicability);
>
> (2) assess the potential contribution of each research proposal to the four areas for impact under the IRP's 2026-2029 Vision for Impact (governance, finance, provisioning systems and circular solutions , and regionalization); and
>
> (3) circulate relevant documents to inform discussions by IRP members, including at a virtual meeting that took place on 23 July 2025.

After the July 2025 virtual consultation, the Secretariat invited written feedback on the work programme. Based on written feedback received, the work programme proposal was revised, presented to the IRP Co-Chairs for initial feedback, and subsequently presented to a virtual Steering Committee member consultation held on 26 September 2025.

This document reflects the outcomes of the above process conducted in 2025. The 2026-2029 Work Programme proposal will be presented and discussed at the 34th meeting of the IRP from 3-7 November 2025. Panel members are presented the work programme for input and recommendation, and Steering Committee members are presented the work programme for approval.

Main Elements of the 2026-2029 Work Programme

The IRP Work Programme document is a guiding framework of action for the IRP in 2026-2029 that outlines:

- The IRP Theory of Change and Vision for Impact (2026 – 2029)
- The target audiences and processes to engage in 2026-2029
- The high-impact priority areas (HIPAs) for research in 2026-2029
- The science-policy expertise needed to achieve the desired impact
- The resources needed to effectively deliver and how to mobilize them

- A monitoring and evaluation framework for the 2026-2029 period

This executive summary provides the highlights of the above sections; while the 2026-2029 work programme document (IRP.34.08.01) goes into detail.

II. Theory of Change and IRP Vision for Impact (2026–2029)

In a world shaped by resource insecurity, contested geopolitics, and accelerating environmental crises, the IRP will serve as a compass - offering rigorous, policy-relevant science to navigate complex transitions. The 2026–2029 Work Programme positions natural resource management as a foundation for delivering global ambitions across climate, biodiversity and land, pollution and equity. As systems of food, housing, energy, and mobility – as well as digital infrastructures - undergo transformations that are fundamentally shaped by natural resources use, the IRP will provide the evidence base to guide decisions toward sustainability, resilience, and equity. The IRP produces independent, policy-relevant assessments across the natural resource life cycle; co-creates and tailors knowledge for regions and sectors with clear policy hooks and impact pathways; and catalyzes uptake in multilateral, international and industry/private sector arenas. Through these activities, the IRP will enhance the visibility, usability, and reach of science in support of just and effective resource transitions. In 2026-2029, its impact will be driven through four priority areas: strengthening natural resources governance at all scales; aligning finance to resource efficiency, circularity and sustainability; supporting transformations in provisioning systems through resource efficient and circular solutions; and tailoring insights to regional and other contexts. The magnitude and extent to which the IRP can deliver on its Vision for Impact 2026-2029 is directly tied to the financial resources contributed by its membership and other sources towards these aims.

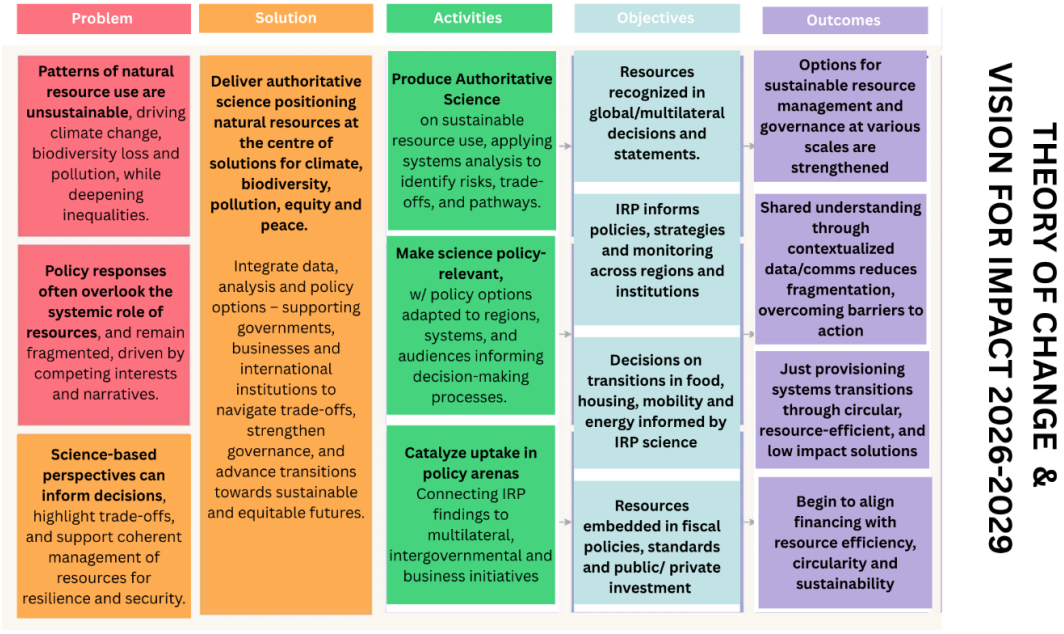


Figure 2: IRP Theory of Change and Vision for Impact 2026-2029

III. Engaging more and better with IRP audiences and stakeholders

The 2026-2029 Work Programme prioritizes development of IRP knowledge is timely, accessible and useful to those shaping sustainability transitions. Primary audiences are threefold. First, governments and intergovernmental platforms, including national governments represented on the IRP Steering Committee and their statistical offices, UNEA, HLPF and UNGA, intergovernmental science-policy bodies such as IPCC, IPBES, UNCCD-SPI and the SPP, and relevant MEAs to which they report, notably UNFCCC, CBD and UNCCD. Second, regional groupings and economic and political unions, with deeper engagement planned with G7, G20 and G77, and recognition of the growing influence of BRICS+, regional coalitions and other South-led platforms on energy, minerals, land and finance. Third, private sector and financial actors, including industry associations and consortia such as WBCSD, ICMM, ICC and WEF, development banks and agencies, and industries linked to digital transitions and defense that depend on metals and materials.

Other target audiences and stakeholders include UN regional commissions (UNECA, UNESCAP, UNECE, ECLAC, UNESCWA), the UN Resident Coordinator system, and organizations such as OECD, World Bank, IMF and UNDP. Multi-stakeholder platforms and CSOs, including GGKP, GACERE, the One Planet Network and UN Major Groups, can help translate and amplify IRP findings. Academic networks and think tanks contribute cutting-edge input and support wider uptake.

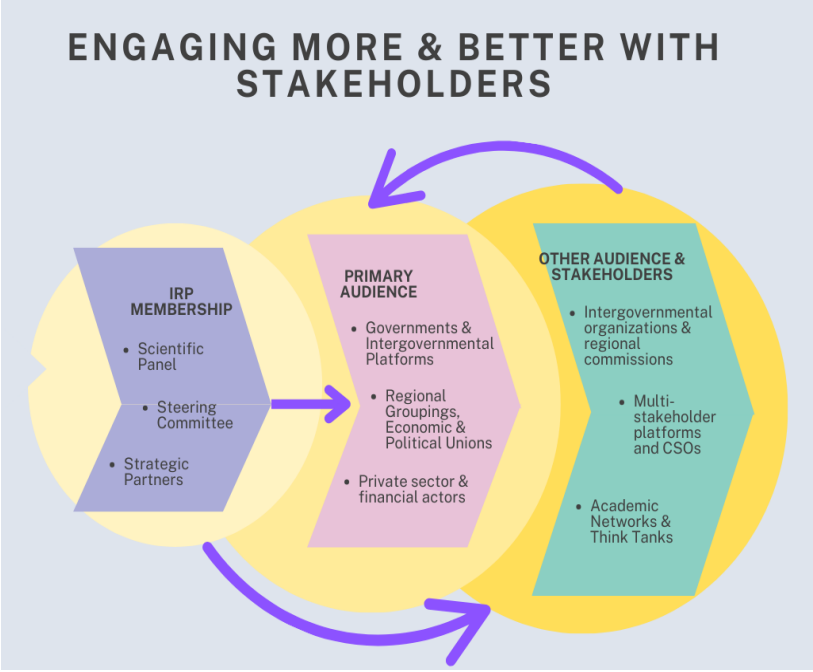


Figure 3: IRP Primary Audiences and Other Stakeholder in 2026-2029

Communication and partnerships are expected to be embedded as central components of IRP research development and outreach, with collaboration strengthened especially through a

reinvigorated and expanded strategic partners network.[1] As part of this process, UNEP has stepped forward with proposals for strengthening the linkages with ongoing policy processes, communications and knowledge management of the IRP.[2]

It is expected that product-specific audience engagement and communication strategies will be prepared for each IRP research product. The level of delivery of these plans and their impact is proportionate to the resource availability within the IRP budget envelop to support expanded outreach, especially with IRP Strategic Partners. Resource Mobilization above historical contributions to the IRP is needed to enable more in-depth audience and stakeholder engagement to achieve the level of impact desired by IRP members.

IV. Developing Policy-Relevant Science: High Impact Priority Areas

The 2026–2029 Work Programme organizes IRP research within **four High Impact Priority Areas (HIPAs)** that together frame how the Panel develops policy-relevant science. These are the same HIPAs carried forward from the 2022-2025 Work Programme.

- **HIPA 1 – Current trends and future prospects for global resource use and sustainable resource management:** builds the IRP's analytical and data backbone, providing metrics, models, and assessments of global resource use, its drivers, and environmental impacts.
- **HIPA 2 – Sustainable resource management for effective action on climate change, biodiversity, and pollution:** strengthens the evidence base linking resource use to global environmental goals and supports coherence among the UNFCCC, CBD, UNCCD and other frameworks.
- **HIPA 3 – Sustainable resource management for effective action on human health, well-being, prosperity, and equity:** explores the social dimensions of resource use, connecting sustainability transitions with inclusive development and distributional outcomes.
- **HIPA 4 – Enabling sustainability transitions:** focuses on pathways, governance mechanisms, and enabling conditions - such as finance, trade, and policy instruments - that support circularity and low-impact provisioning systems.

Each HIPA is composed of **workstreams**, which define broad thematic areas under which specific **research products** are proposed. Within each workstream, research products are categorized as either *Core Priority Products* or *Potential Products*.

[1] Expansion of the IRP Strategic Partner Network will be pursued as resources allow.
[2] Please see document 34.IRP.15 *UNEP Management Response to International Resource Panel Strategic Review and Steering Committee Asks_Revised version*

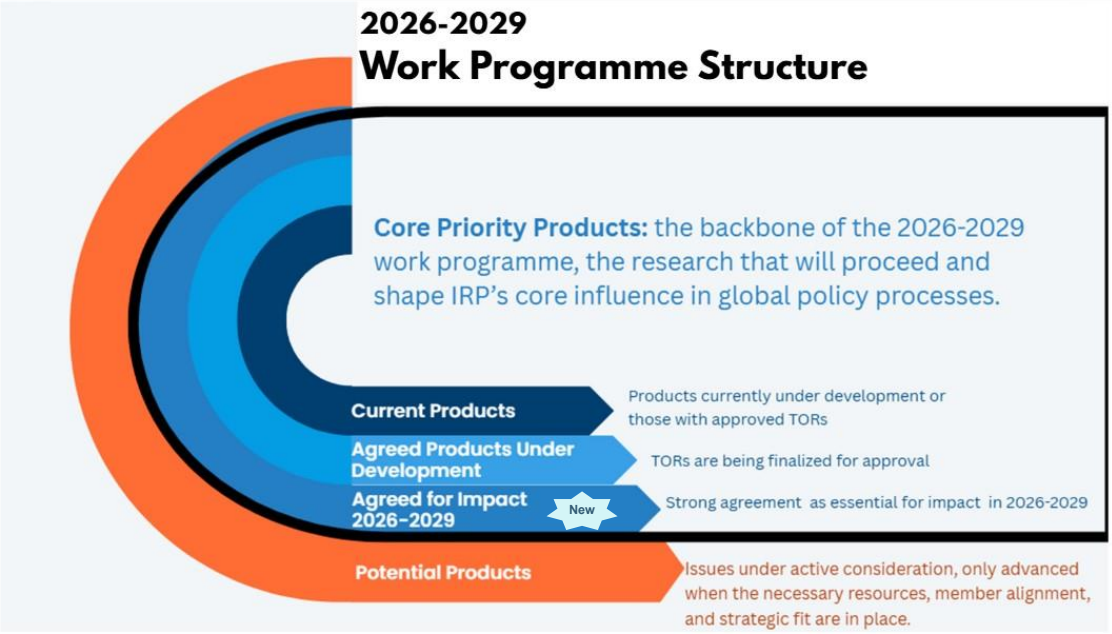


Figure 4: Work Programme Structure 2026-2029

Core Priority Products are those that the IRP commits to deliver within the 2026–2029 cycle. They reflect clear policy demand, strategic alignment with IRP's Vision for Impact, available expertise and, indicatively, available financial resources based on historical contributions to the IRP.

Core Priority Products include three categories. The first, **Current Products**: any research products that are currently under development or those with approved TORs, and that may not be completed by the end of 2025, which will be carried over to the 2026-2029 work programme.

Second, **Agreed Products Under Development:** High-priority work where TORs are being finalized for approval which is expected by the end of 2025. The work will begin in 2026.

For these first two categories, financial resources have either already largely been allocated or are expected to be allocated imminently.

The third category, **Agreed for Impact 2026-2029 (new):** includes research areas which emerged as part of the Strategic Planning Exercise with strong agreement as being strategically essential for the IRP in 2026-2029. It is estimated that based on historical contributions, the IRP will have sufficient funds to deliver on the proposed Core Priority Products – but the level of contextualization, scale of impact and outreach for each is contingent on the ability to mobilize additional resources to support their development.

Category	HIPA	Title	Type	Expected Launch
Current Products	**HIPA-1**	Global Material Flows Database (Phase III)	Scientific Assessment	2026
		Science Based Targets (Phase I)	Rapid Study	2026
	HIPA-2	Decarbonizing Global Cities	Scientific Assessment	2027
		Circular Economy & Consumer Electronics	Scientific Assessment	2026
	HIPA-3	Socioeconomic Impacts of RE& CE	Scientific Assessment	2026
Agreed Products under Development	**HIPA-1**	Global Resources Outlook 2028	Scientific Assessment	2028
		Scenario Modelling (including for GRO28)	Scientific Assessment	2028
Agreed For Impact (2026-2029)(new)	**HIPA-1**	Science Based Targets (Phase II)	Scientific Assessment	2029
	HIPA-2	Critical Transition Minerals Phase I	Rapid Study	2027
		Critical Transition Minerals Phase II	Scientific Assessment	2029
		Resource Efficiency and Circular Economy Strategies for a Sustainable Bioeconomy	Scientific Assessment	2027
	HIPA-4	Financing and Investment for Sustainable Resource Use(including Trade)	Rapid Study	2029

Table 1: Core Priority Products of the 2026-2029 Work Programme, by three categories (Current Products, Agreed Products Under Development, and Agreed for Impact 2026-2029 (new).

The second part of the 2026-2029 Work Programme structure consists of **Potential Products**: additional studies that could be developed if emerging policy needs, Steering Committee consensus, or new resources become available. They provide flexibility to respond to new international agendas or requests while maintaining overall coherence. Potential Products may evolve into Core Products once a Terms of Reference (ToR) is formally submitted and approved. Based on historical budget estimated, the Secretariat estimates that two Rapid Study Potential Products could be developed in 2026-2029. The list of potential products included in the 2026-2029 work programme reflects research proposals which received a medium-to-high assessment based on the criteria for assessment proposed by the Steering Committee.

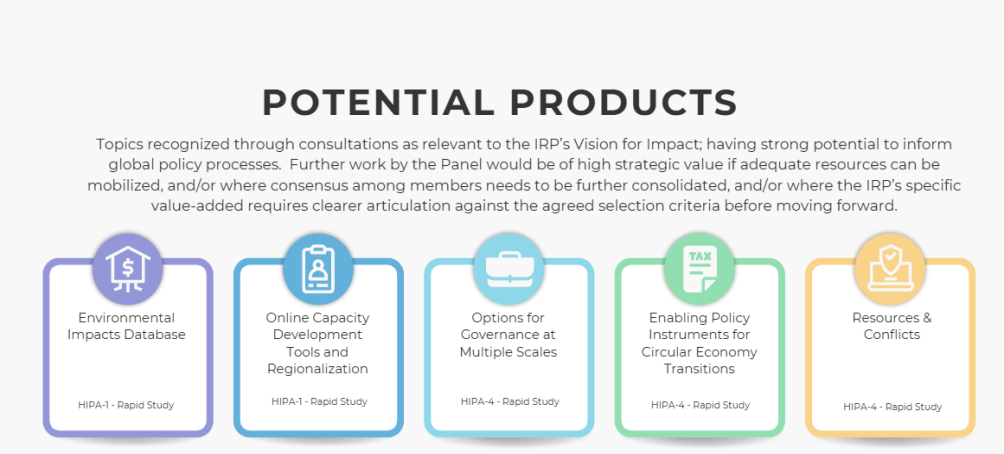


Figure 5: IRP Potential Products included in the 2026-2029 Work Programme.

Work Programme Rollout:

Panel members will develop Terms of Reference (ToRs) for each proposed study in line with IRP Policies and Procedures. The Steering Committee will guide the timing and prioritization of ToR submissions to ensure balanced delivery of work over the four-year cycle, budget cash flow, and responsiveness to emerging needs.

All research proposals will be evaluated using the Assessment Criteria established by the IRP Steering Committee members at 33 IRP and through subsequent consultations. These are: relevance, impact, expertise fit, feasibility, scientific rigor, and communicability. These criteria ensure that the IRP's research remains strategically focused, scientifically credible, and policy-relevant throughout the 2026–2029 cycle.

Figure 6: Assessment Criteria for all research products to be developed in 2026-2029

Table 2: Overview of all products under the 2026-2029 Work Programme (Core Priority and Potential Products)

Workstream	Research Product	Type	Status	Expected Release/Launch date
HIPA-1 Current trends and future prospects for global resource Use and Sustainable Resource Management				
Core Priority Products				
Metrics and Data for Sustainable Resource Use	Global Material Flows Database Phase III	Database (Scientific Assessment)	Current	2026
Defining Sustainable Levels of Resource Use (Science-Based Targets);	Defining Sustainable Levels of Resource Use (Science-Based Targets *Phase I*)	Rapid Study	Current	2026
	Defining Sustainable Levels of Resource Use (Science-Based Targets *Phase II*)	Scientific Assessment	Agreed for Impact (New)	2028

Workstream	Research Product	Type	Status	Expected Release/Launch date
Scenario Modelling of Integrated Natural Resource Management	Scenario Modelling (including for GRO2028)	Database (Scientific Assessment)	Agreed Products Under Development	2028
The Global Resources Outlook (IRP flagship report)	Global Resources Outlook 2028	Scientific Assessment	Agreed Products Under Development	2028
Potential Products				
Metrics and Data for Sustainable Resource Use	Environmental Impacts Database	Database (Rapid Study)	/	/
Tools & Capacity Development for Application at Different Scales	Online Capacity Development Tools and Regionalization	Database (Rapid Study)	/	/
HIPA-2 Sustainable Resource Management for effective action on climate change, biodiversity, and pollution				
Core Priority Products				
Sustainable Resource Management Solutions in Provisioning Systems and Sectoral Linkages	Decarbonizing Global Cities with Environment, Health & Biodiversity Co-Benefits	Scientific Assessment	Current	2027
	Critical Transition Minerals for Energy, Mobility and Digitalization (Phase I)	Rapid Study	Agreed for Impact (New)	2027
	Critical Transition Minerals for Energy, Mobility and Digitalization (Phase II)	Scientific Assessment	Agreed for Impact (New)	2029
Workstream	**Research Product**	**Type**	**Status**	**Expected Release/Launch date**
Sustainable Resource Management for Resource Efficient and Circular Value Chains	Advancing the Circular Economy and Consumer Electronic Markets	Scientific Assessment	Current	2026
	Resource Efficient and Circular Economy Strategies for a Sustainable Bioeconomy	Scientific Assessment	Agreed for Impact (New)	2027
Potential Products				
None				

Workstream	Research Product	Type	Status	Expected Release/Launch date
HIPA-3 Sustainable Resource Management for effective action on human health, wellbeing, prosperity, and equity				
Core Priority Products				
Socio-economic/distributional implications of sustainability transitions	Socio-economic implications of enhancing resource efficiency and promoting circular economy	Scientific Assessment	Current	2026
Potential Products				
None				
HIPA 4: Enabling sustainability transitions				
Core Priority Products				
Finance, investment and trade system needed for sustainable resource management	Financing, Investment and Trade for Sustainable Resource Use	Rapid Study	Agreed for Impact (new)	2029
Potential Products				
Trade and transboundary resource use	/	/	/	/
Business model, digital & other technological innovations for sustainability transitions	Enabling Policy instruments for Circular Economy Transitions	Rapid Study	/	/
Options for sustainable resource management	Options for Coordinated Resource Governance at Multiple Scales	Rapid Study	/	/
	Resources and Conflicts	Rapid Study	/	/

V. Mobilizing the Best Science-Policy Expertise

Panel Membership

As of October 2025, the Panel has 41 members (including 2 Co-Chairs and 12 new Panel Members on a one-year engagement period). The objective of the IRP Panel membership strategy in 2026-2029 is to continue strengthening and diversifying the global scientific panel. To achieve this, the Secretariat - with support from IRP Panel Members - will periodically review the expertise available and assess gaps considering: (1) ongoing and future research needs, (2) the status of members who have reached the end of their maximum possible terms (12 years); and (3) engagement of members who have reached their maximum term in active working

groups. On that basis, the Secretariat will follow IRP Policies and Procedures to recruit new scientists.

By the end of the 2026-2029 work programme, up to 21 Panel members may have reached their maximum term limits and could end their membership with the Panel. Therefore, up to 21 new Panel member positions could become available over the course of the 2026-2029 work programme.[3] While every opportunity will be made to continue to engage Panel Members whose terms have ended in future working groups as relevant, and while their expertise and outreach may be called on to support ongoing IRP activities – this none-the-less heralds a significant change in IRP membership (up to over 50% turnover). The 2026-2029 cycle is therefore a cornerstone cycle to shape an IRP Panel membership that is future fit in terms of its expertise, gender balance and regional representation.

Steering Committee

The IRP Steering Committee, currently composed of 34 UN Member States plus the European Commission and UNEP, will aim to be expanded to approximately 45 members to improve global balance and strengthen representation from Africa, Latin America and the Caribbean, West Asia, and Asia and the Pacific. Expansion will be supported by outreach from the four IRP Co-Chairs, Secretariat, and Panel members. Member engagement will be reinforced through induction sessions for new members, regular intersessional meetings, early circulation of documents, and opportunities for members to participate in dissemination and review of IRP outputs. The aim is to ensure active participation, continuity of representation, and stronger alignment of IRP outputs with national, regional and intergovernmental policy processes.

VI. Mobilizing Financial and In-Kind Support for Effective Delivery

To achieve the desired impact, the IRP must ensure that funding matches its ambitions. Figure 7 proposes an indicative rollout of Core Priority Products and Possible Products based on the budget projected for 2026-2029. This projected budget is based on historical trends in IRP financing from OECD Steering Committee members and considers that contributions will remain at least stable over the 2026-2029.

Based on historical contributions from IRP members, total expected income between 2026-2029 is approximately US$7.6 million. The total cost for the 2026-2029 Work Programme research outputs – including Core Priority Products and two Rapid Study Potential Products – is estimated[4] at US$3.2 million. In addition, an estimated total of $6.3 million will be required to

[3] Depending on the engagement of members who have reached their maximum term in active working groups.
[4] Costs are based on Annex 4 of the 2022-2025 IRP Work Programme, and include US$350,000 for a full assessment, US$ 200,000 for a rapid study and US$125,000 for a think piece. This estimate includes all costs of contracting, editing, printing, and working group meetings. The actual cost of IRP assessments and think pieces may differ depending on the scope and nature of the publication. Detailed cost estimates will be added to annual IRP budgets as more information becomes available. For Rapid Studies in the 2026-2029 work Programme, a standard cost of US$175,000 has been applied, considering that any in-person working group meetings could be convened back-to-back with annual in-person IRP meetings, or virtually as necessary.

cover for operational costs[5] of the IRP in 2026-2029. It is expected that approximately US$1.9 million will be carried over from the 2022-2025 work programme (of which approximately US$1.2 million is earmarked funding for Current Products and Operations under the European Commission DG Research and Innovation Contribution Agreement to the IRP from 2025-2027[6]; and of which approximately US$200,000 is short term funding to be expended by 2026).

It should also be noted that in 2022-2025, the IRP has benefitted in-kind from an agreement between the SUN Foundation and Systemiq, which has supported (in-kind) Secretariat functions, as well as the primary functions of one IRP Panel Co-Chair. This agreement, and the financial support it benefitted from, ends in 2026.

As per articles 9 and 10 of the IRP Policies and Procedures, SC members from OECD countries **shall** provide annual financial contributions to the IRP, while SC members from non-OECD countries shall strive to provide these as far as possible. Non-earmarked, multi-year financial contributions are strongly encouraged as they will facilitate effective and timely implementation of the Work Programme. Both OECD and non-OECD SC members are also encouraged to provide in-kind contributions to the IRP.

The majority of current IRP funding comes from the European Commission (a multi-year contribution agreement with DG Research and innovation which covers between 55-62 per cent of the total IRP income between 2026-2027). Of the total 16 OECD members of the IRP Steering Committee, five IRP OECD Steering Committee members contribute over US$100,000 each per year. Five other IRP Steering Committee members contribute under US$100,000 per year (between US$45,000 - US$70,000). Six OECD Steering Committee members do not make annual financial contributions to the IRP.

Resource Mobilization Efforts by UNEP: Based on consultations with UNEP Senior Management and the IRP Co-Chairs and membership, in addition to mobilizing in-kind support to the IRP from existing UNEP staff and expertise, UNEP has pledged to support the staff salary of the P-5 Position within the IRP Secretariat (estimated at approximately $200,000 per year), and, to allocate $250,000 to support the integration of the Global Material Flows Database to the UNEP World Environment Situation Room (WESR). These funds have not yet been integrated into the IRP Financial Projections and would be in addition to budget projections presented here, once timelines for implementation are confirmed. Please see IRP.34.15 UNEP Management Response to International Resource Panel Strategic Review and Steering Committee Asks_Revised version for the full proposals by UNEP.

If all current IRP OECD members contributed annually US$100,000, and members who contribute above that amount maintain their annual contribution levels, then the projected IRP

[5] The operational costs include secretariat staff salaries, travel and meeting logistics, general communications and outreach including website maintenance and regional activities, capacity building, project evaluation and the mandatory coordination levy to support the UN Resident Coordinator system and programme support costs.
[6] Note that of the US$1.2 million DG Research and Innovation Contribution Agreement, US$550,000 are planned to be obligated in Q4 2025 to cover two Core Priority Products (development of Global Material Flows Database and the Scientific Assessment on Decarbonizing Global Metropolitan Areas).

income for the 2026-2029 Work programme period would be US$11 million, that is - an additional US$3.4 million from current projected levels).

With an expanded budget envelop, the IRP could foresee delivery on all Core and Potential Research products. In addition, the IRP could dedicate resources to developing and delivering products tailored to specific audiences, or multi-media and communication assets to elevate the reach of IRP impacts. Increased ambition related to audience engagement, especially related to activating the IRP Strategic Partnership network, requires dedicated resources and financing beyond what is possible within the current budget envelop. Hence, Resource Mobilization is a critical aspect of the 2026-2029 work programme to enable expanded ambition and impact of the IRP. The main target sources of funding for 2026-2029 will be Steering Committee members and Strategic Partners. Other potential donors include foundations and private sector organizations, national development organizations in partnership with relevant IRP Steering Committee members, or joint-fundraising with IRP Panel members by identifying relevant 'calls for proposals' that may support the IRP work programme delivery.

In addition, Steering Committee members may consider supporting a reduced expected IRP operational cost by, for example, secondment or Junior Professional Officer positions to support the IRP Secretariat, self-funding or supporting Panel member travel to outreach or IRP meetings, hosting of IRP in-person meetings, or supporting research communications and outreach, including through translations, by in-kind contributions among others.

Rollout of research projects is only proposed to begin when it is reasonably expected that the full costs can be covered by available budget. This is because the Secretariat cannot enter into contractual agreements for research development until the full amount of financial resources required is available in IRP accounts. Table 3 on the following page lists the Core priority and Possible Research Products in entirety, and their related expected future costs.

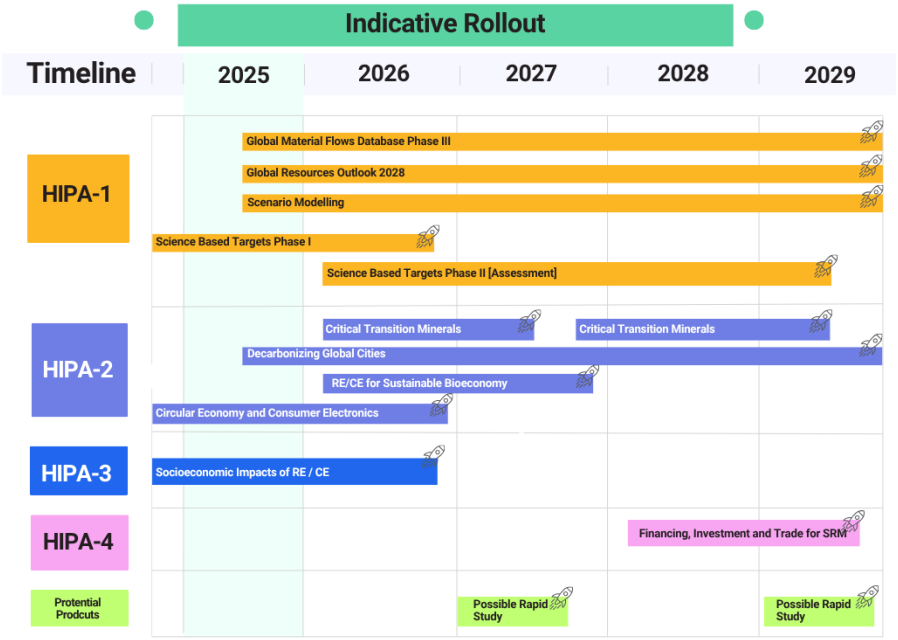


Figure 7: Indicative rollout of 2026-2029 work programme

HIPA	Status	Outputs	Approved budget	Budget for 2026-2029	Type of Product	Totals	Total Funding	Total
HIPA 1	Current Products	Science-Based Targets (Phase I)	150,000	45,000	Rapid Study	1 x Rapid Study 3 x Scientific Assessment 1 x Flagship Scientific Assessment	$1,591,000	**Core Priority Products: $2,881,000** **Total Potential Products: $750,000**
		Metrics & data for sustainable resource use (Phase III)	346,000	346,000	Scientific Assessment (**Database**)			
	Agreed Under Development	Global Resources Outlook 2028	-	450,000	Flagship Scientific Assessment			
		Scenario Modelling (incl. for GRO28)	-	500,000	Scientific Assessment (Database)			
	Agreed for Impact (new)	Science-Based Targets Phase II	-	250,000	Scientific Assessment			
	Potential Products	Environmental Impacts Database	-	150,000	Rapid Study (Database)	2 x Rapid Study	$300,000	
		Online Capacity Development Tools and Regionalization	-	150,000	Rapid Study			
HIPA 2	Current Products	Advancing the Circular Economy in Consumer Electronic Markets (2024)	249,322	45,000	Scientific Assessment	1 x Rapid Study 4 x Scientific Assessment	$1,070,000	
		Decarbonizing Global Cities	350,000	350,000	Scientific Assessment			
	Agreed for Impact (new)	Critical Transition Minerals Phase I	-	175,000	Rapid Study			
		Critical Transitions Minerals Phase II	-	250,000	Scientific Assessment			
		Resource Efficiency and Circular Economy for a Sustainable Bioeconomy	-	250,000	Scientific Assessment			
	Potential Products	-	-	-	-	$0	$ 0	
HIPA 3	Current Products	Socioeconomic Implications of Enhancing Resource Efficiency and Promoting Circular Economy (2023)	285,000	45,000	Scientific Assessment	1 x Scientific Assessment	$45,000	
	Potential Products	-	-	-	-	$0		
HIPA 4	Agreed for Impact (new)	Financing, Investment and Trade for Sustainable Resource Use	-	175,000	Rapid Study	1 x Rapid Study	$175,000	
	Potential Products	Options for Coordinated Resource Governance at Multiple Scales	-	150,000	Rapid Study	1 x Rapid Study	$450,000	
		Enabling Policy Instruments for Circular Economy Transitions	-	150,000	Rapid Study	1 x Rapid Study		
		Resources and Conflicts	-	150,000	Rapid Study	1 x Rapid Study		

Table 3: All Core Priority Products and Potential Products proposed under the 2026-2029 Work Programme. It is estimated that of the total US$750,000 that would be required to produce all Potential Products, only US$300,000 would be available based on income projections.

II. WORK PROGRAMME 2026-2029

CONTENTS

1. Background

As per paragraph 73(a) of the Policies and Procedures of the International Resource Panel (IRP), every four years, the IRP Secretariat carries out a Strategic Planning Exercise to develop the IRP Work Programme. The IRP Secretariat launched the 2025 Strategic Planning Exercise (SPE) shape the Panel's 2026–2029 Work Programme at the 32nd Meeting of the IRP (December 2024).

Based on the SPE conducted, this document provides the strategic direction of the IRP in 2026-2029 to ensure the achievement of its main objective which is "*to contribute to a better understanding of sustainable development from a natural resources perspective, providing science-based policy options on how to decouple economic growth from environmental degradation while enhancing human well-being*". The 2026-2029 IRP WP is also aligned with the objectives of UNEP's Medium-Term Strategy for 2026-2029.

This document is a guiding framework of action for the IRP in 2026-2029 that outlines:

- The IRP Theory of Change and Vision for Impact (2026 – 2029)
- The target audiences and processes to engage in 2026-2029
- The high-impact priority areas (HIPAs) for research in 2026-2029
- The science-policy expertise needed to achieve the desired impact
- The resources needed to effectively deliver and how to mobilize them
- A monitoring and evaluation framework for the 2026-2029 period

2. Theory of Change

The theory of change builds on the framework developed for the 2022-2025 work programme and has been updated to reflect an evolving multilateral and geopolitical landscape, and the changing role of science-policy panels within it. The Theory of Change continues to guide the research, activities, and strategic long-term actions of the IRP, while the Vision for Impact has been developed specifically for the 2026-2029 work programme period.

2.1 The problem analysis

Current patterns of resource use – driven by economic growth and wasteful, linear production and consumption – are unsustainable. They underpin climate change, biodiversity loss, land degradation and pollution, while deepening income inequalities. This trajectory poses escalating risks to human wellbeing, including food, water and energy security, and jeopardizes the achievement of global environmental agreements. Competition over scarce resources and the instability that follows can heighten tensions within and between societies, threatening peace and security at multiple scales.

Societies must recognize that current resource management practices are untenable and that sustainable alternatives are achievable. Policies are needed to ensure fair and efficient resource use, balancing environmental, social and economic costs and benefits. Scientific information is essential to understand problems, evaluate solutions and monitor progress.

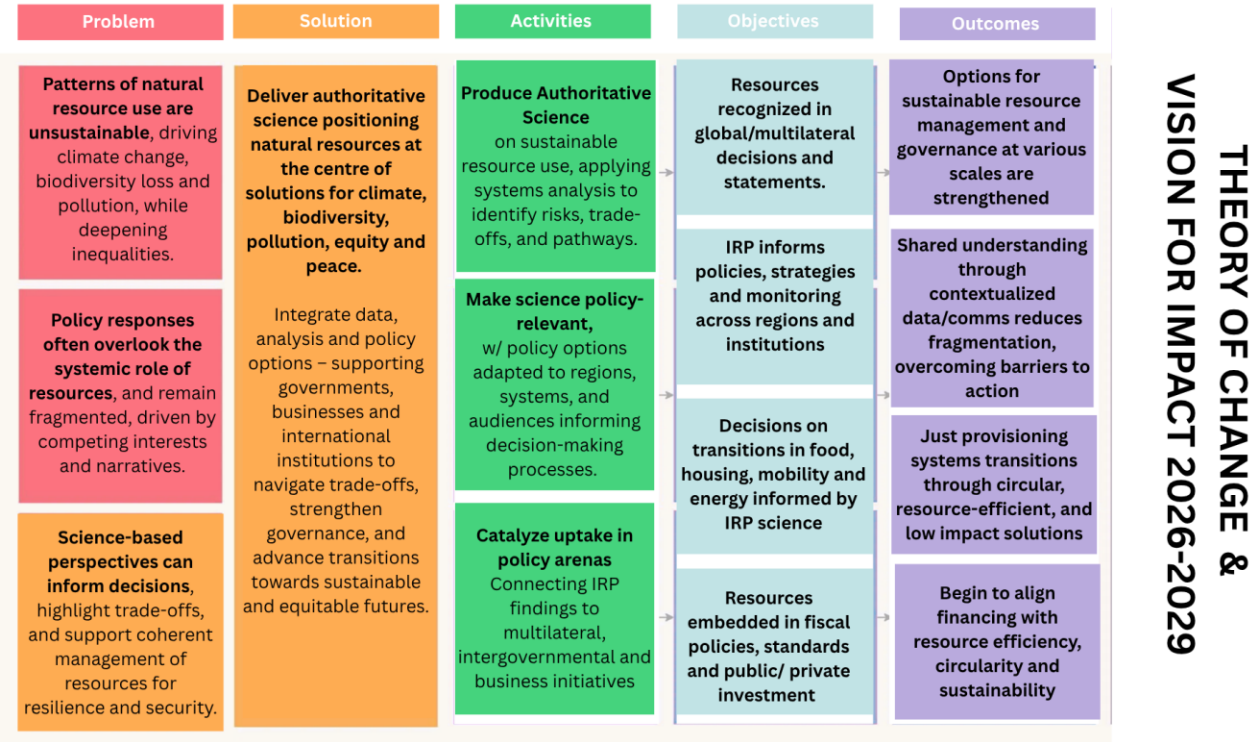


Figure 1: IRP Theory of Change and 2026-2029 Vision for Impact Objectives and Outcomes

Policy action begins when decision makers acknowledge an issue's importance and reach consensus. Yet many lack clear, accessible science to inform decisions, resulting in fragmented, incoherent policies that overlook systemic linkages. Often, political actors appeal to disparate scientific findings to support competing narratives. Authoritative scientific assessments can raise issue salience, clarify trade-offs, and support coherent policy development.

Once politicians have decided to act, policy makers proceed by formulating plans and rules, and finally the implementation of strategies. Here, more detailed scientific information can be required to make decisions about specific rules and strategies. Finally, there should be monitoring of the issues at hand and an evaluation of the effectiveness of implemented policies.

The practice of rational decision making, in which evidence and understanding of causal relationships comes to bear and is critically examined and agreed upon is itself contested. Other types of decision making, based on preconceived notions and theories, is common and does not recognize the role of science in decision support. In any case, political processes and cultural precepts shape decision making. The advantage of rational decision making is that it is a basis for achieving agreement for people with different world views and interests, if they agree on critical rationality.

Scientific awareness alone is not enough to drive policy action, particularly in today's shifting geopolitical landscape where resource governance is increasingly shaped by power competition. It may be the case that geopolitical interests take precedence over sustainability concern, and science is disregarded in favour of short-term strategic priorities. Addressing this reality is crucial to ensuring that sustainable resource management remains a central focus in global decision-making.

2.2 Solution: The International Resource Panel

The International Resource Panel (IRP) is a science-policy interface promoting the sustainable use and management of natural resources as a foundation for environmental, economic and social sustainability. It advances understanding of sustainable development from a resource perspective, providing science-based options to decouple growth from environmental degradation while enhancing well-being. The IRP delivers authoritative, integrated science that places resource use at the centre of global solutions, offering evidence-based pathways to decouple prosperity from environmental harm across country contexts. Its assessments connect data, systems analysis and policy insights, helping governments, businesses and institutions navigate trade-offs, strengthen governance, and align finance, trade and innovation with sustainable resource management. By positioning resources as a shared foundation for climate, biodiversity and land, equity and peace, the IRP supports coherent decision-making and advances just and resilient futures.

2.3 Activities and the Role of the IRP

The IRP:

- ✓ **Produces independent, coherent, and authoritative scientific studies and assessments of policy relevance** on the sustainable use and management of natural resources and their environmental and socio-economic impacts over the full life cycle.
  The IRP's assessments have any of the following functions:
  - Raising awareness of unsustainable resource use, its impacts, and future risks by linking current practices to likely adverse consequences.
  - Identifying and evaluating solution pathways and policy targets that can address problems and deliver more sustainable outcomes.
  - Providing authoritative analysis on contested issues, offering policymakers trusted information amid conflicting evidence.
  - Assessing existing or proposed policies and their impacts across multiple dimensions to inform and improve policymaking.
  - Monitoring trends over time to guide implementation and track progress toward sustainability goals.
  - Supplying a coherent knowledge base for international and transnational policy processes and agreements.

- ✓ **Makes science policy relevant by** creating relevant, reliable, timely and targeted knowledge; co-creating knowledge with multi-scale partners; translating findings for regional and national contexts, ensuring relevance across different geographies and constituencies; having clear policy 'hooks'; stipulating impact pathways for agents of change; and tailoring communication to different stakeholders.

- ✓ **Catalyzes uptake in policy arenas** by informing international and national policy discourse and industry and the private sector on emerging challenges and opportunities for the sustainable use and management of and equitable access to natural resources

2.4 The outcomes and impact pathway

In the long term, the desired impact is that, through its work, the IRP enables policymakers, business leaders and other stakeholders to better understand the environmental, social and economic implications of resource use and the pathways - such as decoupling - toward sustainability. Its findings inform decisions on resource management across the full life cycle, from design to reuse and recycling, and are increasingly applied by governments and the private sector through collaboration with industry and academia, including economic and financial impact analyses of policy options. The IRP's evidence also shapes wider policy discourse, influencing international organizations, research institutions, civil society and businesses that act directly on resource management.

Targeted outreach will strengthen the use of IRP science by governments, UN bodies and businesses positioned to translate findings into action. In doing so, the IRP helps design policies that promote sustainable resource management, mitigate adverse impacts, and create opportunities for well-being, resilience and equity. The Panel remains committed to scientific excellence while increasing the visibility, policy relevance and practical utility of its work to advance global sustainability transitions.

2.4.1 The vision for IRP impact in 2026-2029

As the 2030 Agenda enters its final stretch, key systems - energy, mobility, digital infrastructure, the built environment, and food - are undergoing fundamental transitions. These are, at their core, natural resource and material transitions. We now understand the extent to which climate change, biodiversity loss and land degradation, and pollution are being driven by the unsustainable and linear patterns of natural resources use. We also know that sustainability transitions that deliver on economic growth, wellbeing and environmental agreements – achieving our Pact for the Future - is possible with concerted and coordinated action at all scales. The IRP's work addresses how to balance multiple transitions – creating coherence in how humanity uses resources within the limits of the planet.

Current trajectories of resource use remain far from sufficient to meet these global goals: decoupling has not occurred at scale, circularity remains limited, and environmental pressures continue to rise. Further, geopolitical realignments - including rising resource nationalism, contested trade regimes, and shifting regional, energy, and mineral alliances - are reshaping global cooperation on sustainability.

Building on the Global Resources Outlook 2024 and the achievements of the IRP's 2022-2025 Work Programme, IRP's Vision for Impact for 2026-2029 responds to this complex environment by underscoring the role of science as a compass for decision-making in uncertain times. It seeks to provide clear, data-grounded analysis that tangibly demonstrates how countries and industries at all stages of development can transition toward sustainable resource use - advancing human well-being, economic resilience, and environmental integrity. The IRP will reinforce its commitment to elevating the centrality of natural resource use as a critical and integrated solution space - not only for environmental sustainability, but also for addressing interconnected global challenges across climate, development, equity, and peace. By offering credible and constructive visions of just futures, the IRP supports the global effort to realize a world of healthy people on a thriving planet.

To support this vision, the IRP will continue to produce quality publications with significant added value that responds to the demands of policy needs, grounded in solid science within the remit of its core competence - assessment of the trend of extraction and use of natural resources as well as its environmental impact. It will build on its strong data foundation while placing greater emphasis on

system- and context-specific analysis. This includes continuing to strengthen its core global datasets and developing complementary insights that reflect the realities of key provisioning systems - such as food, housing, mobility, and energy - across diverse regions. The IRP will also work to improve the accessibility and usability of its data to support interpretation and application at different scales. These efforts will be accompanied by increased attention to communication, partnerships, and capacity support, helping to ensure that the IRP's work can inform action in ways that are relevant and responsive to a range of users and policy environments.

2.4.2 Objectives of the 2026-2029 Work Programme:

Four objectives are pursued in the 2026-2029 period:

1. Resources recognized in global/multilateral decisions and statements, guiding strategic action and positioning sustainable resource use at the center of climate, biodiversity and land, pollution and development agendas.

This includes IRP data and insights informing multilateral frameworks and negotiations – including *inter alia* UNFCCC, CBD, UNCCD, the post-2030 Agenda, and the Pact for the Future - anchoring sustainable resource use as essential to delivering sustainability, climate, biodiversity, and pollution goals. The outcome documents and declarations from these processes reflect IRP findings.

2. IRP knowledge informs policies, strategies and monitoring across regions and institutions.

IRP findings are translated into usable, policy-relevant insights and communication products, tailored to regional and sectoral contexts. By making data and analysis accessible and actionable, the IRP enables governments, UN bodies, and development partners to apply its work in strategies, monitoring, and implementation. The IRP strengthens the relevance and usability of its knowledge base by developing tailored tools that enable region-specific analyses and increased capacity to interrogate global data at various scales - particularly in low- and middle-income contexts.

3. Resource considerations embedded in fiscal policies, standards and public and private investment frameworks that align capital with sustainable resource use

At its core, the IRP aims to influence financing in two mutually reinforcing ways. First, by clarifying and advocating for the integration of environmental and social externalities into financial decision-making. This includes emphasizing the cost of inaction and the risks to future returns if global natural resource use continues to grow unchecked through linear economic systems. Cost and benefits of acting to phase up or phase out sustainability practices (for example, scaling action for renewable energy transition (phasing up) and removing fossil fuel subsidies (phasing out)) will equally be explored. Second, the IRP sees a key role in generating evidence to support reforms - such as market-based instruments (e.g. taxes, green subsidies, standards), blended finance models, and financial tracking tools - that can shift investment towards sustainable resource use and management in provisioning systems and through circular business models.

4. Decisions on transitions in food, housing, mobility and energy informed by IRP science on just, circular, resource-efficient and low-impact strategies for different contexts.

The IRP's 2026–2029 Work Programme prioritizes providing the relevant data, analysis and policy-relevant recommendations to support implementation of circular, resource efficient, and low-impact

strategies for system-wide shifts in how societies meet essential needs - such as food, housing, mobility, energy and also waste and digital transitions. These resource intensive provisioning systems are where the material basis of sustainability transitions is shaped and reforming them is essential to decoupling environmental degradation from well-being and economic development. The IRP will focus on identifying and scaling circular and sustainable solutions within these systems, offering evidence-based guidance on the enabling policy, regulatory, and market conditions that foster systemic change.

2.4.3 Outcomes of the 2026-2029 work programme:

Through the activities (Section 2.3), which deliver on the desired objectives (Section 2.4.2), the IRP outcomes for the 2026-2029 work programme are that:

1. **Options for Sustainable Resource Management and governance at various scales are strengthened (Governance)**

Building on Global Resources Outlook 2024 recommendation to institutionalize resource governance and define resource use paths, strengthening the options for sustainable resource management at all scales is a priority because it enables countries and international institutions to make better, more informed decisions about how resources are extracted, traded, consumed, and reused - decisions that are foundational to equitable and effective transitions. Ultimately, the goal is to help ensure that resource use becomes a well-governed, integral part of national development strategies and global policy frameworks.

2. **Aligned Financing with Resource Sustainability (Finance)**

Building on Global Resources Outlook 2024 recommendation to direct finance towards sustainable resource use, financing is increasingly recognized as a linchpin in the IRP's ambition to influence the trajectory of global resource use, decouple economic growth from environmental degradation, and support a just transition. The aim is that, by clarifying the links between unsustainable resource use and long-term economic instability, IRP equips financial actors to reassess value, manage risk, and redirect capital towards sustainable resource use and management in circular and low-impact provisioning systems. In sum, the IRP seeks to influence finance by illuminating the links between public and private investment flows and sustainability outcomes, and equipping policymakers and financial institutions with the data and tools to act.

3. **Transformed Provisioning Systems through Circular, Resource-Efficient, and Low-Impact Solutions (Provisioning Systems and Circular Solutions)**

Building on Global Resources Outlook 2024 recommendation to create circular, resource-efficient, and low-impact solutions and business models; and, to achieve better-performing resource-intensive provisioning systems - IRP elevates recognition that transformations in systems such as food, housing, mobility, energy, and also newly looking at waste and digital transitions, are at their core, material and resource transitions - and provides evidence to ensure that resource use is explicitly addressed in strategies to meet climate, biodiversity, and development goals.

4. **Strengthened Data, Tools, and Communication for Context and Region-Specific Action (Regionalization)**

Regionalization is a thematic priority for the IRP's 2026–2029 Work Programme, aimed at increasing the relevance and usability of IRP data and insights across diverse contexts and geographies. Members have emphasized that IRP's global assessments must better support regional policy

processes - especially in low- and middle-income contexts where capacity to translate global findings is limited. While IRP does not plan to lead full regional outlooks unless the necessary resources can be mobilized, it will ensure its work is adaptable across contexts and that regional actors have the tools, data, and narratives needed to apply IRP insights. Regionalization will be a core delivery model of the IRP, with development of disaggregated outputs for priority regions, capacity development tools and training, and partnerships with regional statistical officers, universities and ministries pursued as resources allow.

3. Engaging more and better with IRP audiences and stakeholders

Members have consistently underlined that excellent science alone is insufficient – the Panel must ensure its knowledge is timely, accessible, and compelling for the institutions and actors shaping sustainability transitions. This requires strengthened engagement at all stages of IRP report development, as outlined in Figure 3 drawn from the 2022-2025 work programme. Additionally, the 'Ten principles to guide the development of IRP outputs' included in Annex 2 of this work programme were developed to increase policy impact in the 2022-2025 cycle and remain valid for the 2026-2029 cycle.

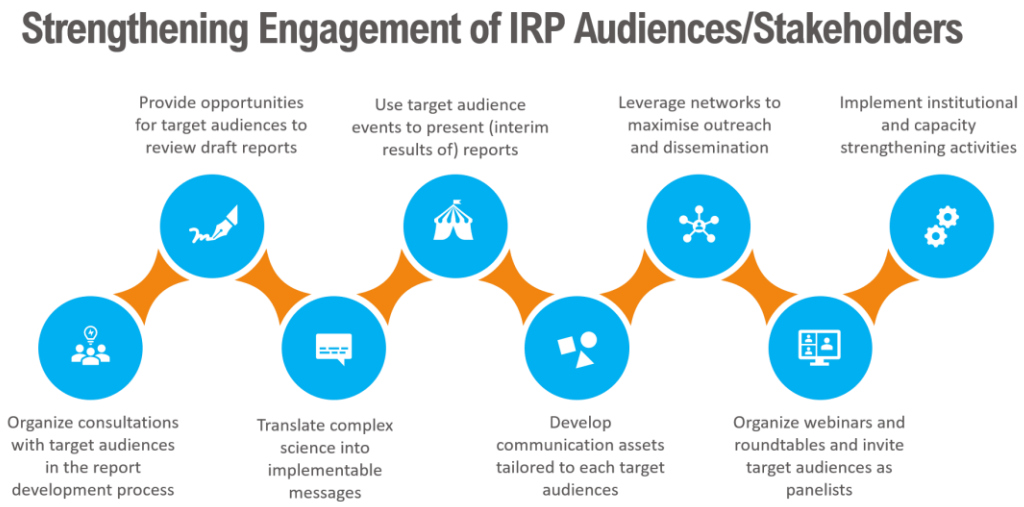


Figure 2: Strengthening engagement of Primary Policy Audiences and Other Stakeholders

A key component of this Work Programme is a commitment to embedding communication and partnerships at the outset of each research stream. By deepening collaboration with strategic partners, and especially UNEP, and by developing tools and narratives that make resource transitions tangible, the IRP will expand its reach and usability – ensuring that its findings inform global frameworks, regional agendas, and national decision-making alike.

It should be noted that in addition to formulating an overarching audience engagement strategy which is presented in the table below, targeted audience engagement/communication strategies will be developed for each IRP research product.

Primary Audiences

To deliver on its Vision for Impact, the IRP identifies **three types of primary audiences** for the 2026–2029 Work Programme:

- **Governments and Intergovernmental Platforms:** National governments (particularly those represented on the IRP Steering Committee and their Statistical Offices), intergovernmental platforms such as UNEA, HLPF and UNGA, as well as intergovernmental science-policy platforms including IPCC, IPBES, UNCCD-SPI, and the Intergovernmental Science-Policy Panel on Chemicals, Waste and Pollution (SPP) – and, where relevant, the Multilateral Environmental Agreements to which they report (UNFCCC, CBD, UNCCD). These audiences remain at the core of IRP engagement, as they shape global frameworks and adopt resolutions that influence sustainability pathways.
- **Regional Groupings and Economic and Political Unions:** With a new focus on contextualization and regionalization, the IRP will deepen engagement with regional and political groupings such as the G7, G20, and G77. In addition, the Work Programme acknowledges the emerging role of new actors as primary audiences. Geopolitical realignments and food, energy, water and resource security concerns mean that BRICS+, regional coalitions, and other South-led platforms are increasingly influential in global decision-making on energy, minerals, land, and finance. Their engagement will be critical to ensuring that sustainability transitions are both equitable and effective.
- **Tier 3 – Private Sector and Financial Actors:** Businesses and financial institutions are now pivotal decision-makers on natural resource use. Industry associations and consortia – such as the World Business Council for Sustainable Development (WBCSD), International Council on Mining and Metals (ICMM), International Chamber of Commerce (ICC), World Economic Forum (WEF) and others – as well as development banks and agencies, are shaping investment flows, supply chain practices, and the pace of circular economy transitions. Engaging also with industries driving the digital transitions, as well as for example defense industries who also require access to metals and materials, could broaden IRP's sphere of influence. The IRP will emphasize strategic engagement with private sector and financial actors, ensuring that IRP science informs standards, strategies, and market instruments that can accelerate sustainable resource management.

Other Target Audiences and Stakeholders

While priority will be given to influencing Primary Audiences, the IRP will also reach out to **Other Target Audiences and Stakeholders** – recognizing their capacity to shape discourse, mobilize action, and extend uptake of IRP findings. Efforts will depend on available resources but will be pursued to enhance IRP's impact, including by expanding and enhancing the IRP Strategic Partner Network[7].

- **Intergovernmental Organizations and Regional Commissions**: These bodies are key to aligning IRP evidence with regional policy agendas, integrating resource issues into development planning, and ensuring IRP findings support multilateral implementation across regions. They include, for example, UN Regional Commissions (UNECA, UNESCAP, UNECE, ECLAC and UNESCWA); UN Resident Coordinator system, and other international organizations such as the OECD, World Bank, IMF, UNDP and other specialized UN agencies involved in environment, finance, or development.

- **Multi-stakeholder Platforms and Civil Society Organizations (CSOs)**: These actors amplify IRP findings across constituencies, help translate technical insights into accessible narratives, and

[7] Current IRP Strategic Partners are: European Environment Agency, Earth Commission, ECLAC, EMF, GIZ, ICC, ISC, IUCN, OECD, 10YFPOPN, PBL, SUN, UN Science-Policy-Business Forum on the Environment; ESCAP, WEF, WRI, Youth and Environment Europe, ICMM, Sitra.

mobilize grassroots and cross-sectoral support for sustainable resource use. Platforms such as the Green Growth Knowledge Partnership, the Global Alliance on Circular Economy and Resource Efficiency, The One Planet Network (10YFP), as well as representatives of the UN Major Groups (e.g. Children and Youth, NGOs, Women, Science and Technology…) are important actors that can help inform, as well as amplify IRP impact.

- **Academic Networks and Think Tanks**: These thought leaders are important to both ensure IRP research is cutting edge and at the forefront of sustainable resource management questions; but also offer important opportunities for uptake of IRP messaging and discourse to amplify the implementation of IRP recommendations.

Box 1: Strategic Partners – Strengthening a Core Network for Impact

In the 2026–2029 Work Programme, the IRP will strengthen its network of **Strategic Partners**, recognizing their vital role both in shaping IRP research and in amplifying its reach across diverse audiences. Strategic Partners bring perspectives from governments, civil society, academia, international organizations, and the private sector – enriching IRP analyses while extending their policy relevance and uptake.

Key steps to enhance the partnership network may include:

1. **Re-engagement of dormant partners** to ensure their expertise and networks contribute actively to IRP outputs and impact pathways.
2. **Active partnership modality**, including quarterly meetings of all Strategic Partners, designed to update them on IRP activities, identify synergies, and align on upcoming opportunities for policy influence.
3. **Enhanced co-production and dissemination**, with Strategic Partners invited to participate in scoping workshops, peer reviews, and joint outreach around reports and events.
4. **Capacity for mutual benefit**, using the network as a channel for co-learning and information exchange.
5. **Joint fundraising initiatives**, piloted with selected partners, to mobilize additional resources for research, outreach, and communication – helping expand the scope and ambition of IRP activities while strengthening ownership and visibility of the network.

Through these measures, Strategic Partners will become an even more integral part of the IRP's impact model – helping ensure that the Panel's science informs not only multilateral processes but also resonates with key actors in regions, sectors, and markets. The extent to which the strategic partners can be activated is directly linked to the human and financial resources that can be dedicated to supporting network building.

4. Developing Policy-Relevant Science: High Impact Priority Areas

This chapter describes the **High Impact Priority Areas (HIPAs)** for research, the framework for how the IRP develops policy-relevant science. It presents how IRP's vision for impact will be delivered through the four HIPAs, following the structure of previous work programmes. Together, the HIPAs develop research outcomes that: improve the *understanding of* natural resource use (HIPA-1); *connect* this understanding to relevant UN SDGs and goals of existing Multilateral Environmental Agreements, especially around climate, biodiversity, pollution (HIPA-2) and health, well-being, prosperity and equity (HIPA-3); and, provide options to *enable* transitions to sustainable management of natural resources (HIPA-4).

Table 1: IRP 2026-2029 High Impact Priority Areas (HIPAs)	
Objective	HIPA
Understanding Natural Resource Use	1. Current trends and future prospects for global resource use and Sustainable Resource Management
Connecting natural resource management with the SDGs	2. Sustainable Resource Management for effective action on climate change, biodiversity and pollution
	3. Sustainable Resource Management for effective action on human health, wellbeing, prosperity, and equity
Enabling sustainability transitions	4. Enabling sustainability transitions

This chapter introduces the overall focus of each of the HIPAs, including the '**workstreams**' – general subject matter headings under which specific research products can contribute – that make up each HIPA. Under each workstream, **research outputs** are categorized as '**Core Products**' or '**Potential Products**'.

For each research output, a broad direction and potential scope of the work, as well as a preliminary assessment based on Steering Committee identified Assessment Criteria for the 2026-2029 work Programme, is described in Document IRP.34.08.03 – Description of Core Priority and Potential Products. Throughout the 2026-2029 cycle, Panel members will be asked to submit Terms of Reference (ToR) in accordance with the work programme. The work programme should guide the preparation of the Terms of Reference which must be prepared for each of the studies following IRP Policies and Procedures. It is only at the approval stage of the Terms of Reference that the final scope, impact, costs and contents of the research products will be finalized and approved.

The Steering Committee provides guidance to Panel members on ToR submission to ensure strategic prioritization and efficient planning in the allocation of IRP resources. The objective of such prioritization will be to provide guidance to Panel members as to the timing of ToR submission over the four years of the Work Programme, while allowing for sufficient flexibility to consider possible, as of yet unidentified, policy needs arising in 2026-2029.

Work Programme Structure:

The work programme is divided into two main categories – Core Priority Products, and Potential Products. The categorization is further elaborated in the box below.

Box 2: Work Programme Structure

1. Core Priority Products

These products form the backbone of the 2026-2029 work programme, the research that will proceed and shape IRP's core influence in global policy processes. Within the Core Priorities, products are arranged into three sub-categories:

- **Active Products** – This includes any research products that are currently under development or those with approved TORs as of September 2025, and that may not be completed by the end of 2025, which will be carried over to the 2026-2029 work programme.
- **Agreed Products Under Development** – High-priority work where TORs are being finalized for approval to move into full development.
- **Agreed for Impact 2026 – 2029 (new)** – Research areas where strong agreement has emerged among members as strategically essential for the IRP in 2026-2029.

2. Potential Products

In addition to the Core Priorities, the IRP has identified a set of research directions that constitute its Strategic Pipeline for 2026–2029. These topics have been recognized through consultations as relevant to the IRP's Vision for Impact and as having strong potential to inform global policy processes. They represent areas where further work by the Panel would be of high strategic value ***if adequate resources can be mobilized, and where consensus among members needs to be further consolidated, or where the IRP's specific value-added requires clearer articulation against the agreed selection criteria before moving forward***.

Maintaining a pipeline of Potential Products allows the Panel to keep these issues under active consideration, while ensuring that new work is only advanced when the necessary resources, member alignment, and strategic fit are in place. This approach provides transparency on possible future directions, while safeguarding/ring-fencing the core focus of the programme and enabling the IRP to respond to policy demand as opportunities arise.

Assessment Criteria: As agreed by the Steering Committee at its 33rd meeting, all research proposals will be assessed against the following criteria: relevance, impact, expertise fit, feasibility, scientific rigor, and communicability. The criteria for assessing proposed research products were developed by Steering Committee members at the 33rd IRP meeting and refined through feedback from all IRP members during subsequent consultations. They are designed to ensure that all IRP outputs in the 2026–2029 Work Programme remain strategically focused, scientifically credible, and responsive to the needs of policy and societal actors. The criteria is further elaborated in Box 3.

Box 3: Criteria for Assessing IRP Research Proposals and Ad-Hoc requests (2026–2029)

Developed by the Steering Committee at 33IRP and refined through member consultations

Relevance – Align with multilateral/regional priorities; Follows up on GRO24 recommendations and/or feeds into GRO28; aligns to 4 key provisioning systems; contributes to Strategic Objectives and Desired Outcomes of 2026-2029 work programme.

Impact – High uptake potential by IRP targets audiences; fills gaps, considering overlap with non-IRP work and extent of unique value-add

Expertise Fit – Builds on IRP's comparative advantage; considers whether specialized expertise is available or requires partnerships.

Feasibility – Clear product type (assessment, rapid study, think piece), realistic within budget and resources.

Scientific Rigor – Strong methodological foundation; can withstand external peer review.

Communicability – Communication and outreach integrated from the outset; possibility of findings to be packaged for usability and influence.

These criteria ensure IRP research supports its 2026–2029 Vision for Impact – shaping global frameworks, aligning finance, transforming provisioning systems, and enhancing regional relevance – while resonating with primary audiences (UNEA, UNGA, HLPF, MEA conventions, G7, G20, BRICS+, private sector and finance) and engaging wider stakeholders (regional bodies, CSOs, academia).

4.1 HIPA 1: Current trends and future prospects for global resource Use and Sustainable Resource Management

HIPA-1 provides the analytical and data backbone of the IRP's work. It monitors the status and trends of natural resource use and its impacts and offers forward-looking scenario analysis to assess the implications of current and alternative development pathways. It supports governments and institutions in understanding and identifying the potential for resource decoupling, and designing more resilient and equitable systems of resource management. HIPA-1 is intended to inform a wide range of global policy processes, including the SDGs and post-2030 Agenda, climate, biodiversity and land conventions, and international efforts on circular economy and sustainable consumption and production.

Under the 2026–2029 Work Programme, HIPA-1 includes 5 workstreams: (1) Metrics and Data for Sustainable Resource Use; (2) Defining Sustainable Levels of Resource Use (Science-Based Targets); (3) Scenario Modelling of Integrated Natural Resource Management; and (4) the Global Resources Outlook (IRP flagship report); and (5) Tools & Capacity Development for Application at Different Scales.

Table 2: Research Outputs for HIPA-1

Workstream	Research Product	Type	Status	Expected Launch date
Core Priority Products				
Metrics and Data for Sustainable Resource Use	Global Material Flows Database Phase III	Database (Scientific Assessment)	Current	2026
Defining Sustainable Levels of Resource Use (Science-Based Targets);	Defining Sustainable Levels of Resource Use (Science-Based Targets *Phase I*)	Rapid Study	Current	2026
	Defining Sustainable Levels of Resource Use (Science-Based Targets *Phase II*)	Scientific Assessment	Agreed for Impact (New)	2028
Scenario Modelling of Integrated Natural Resource Management	Scenario Modelling (including for GRO2028)	Database (Scientific Assessment)	Agreed Products Under Development	2028
The Global Resources Outlook (IRP flagship report)	Global Resources Outlook 2028	Scientific Assessment	Agreed Products Under Development	2028
Potential Products				
Metrics and Data for Sustainable Resource Use	Environmental Impacts Database	Database (Rapid Study)	/	/
Tools & Capacity Development for Application at Different Scales	Online Capacity Development Tools and Regionalization	Database (Rapid Study)	/	/

Some of the key policy-relevant questions HIPA-1 seeks to inform includes:

- What are the current and projected trends in global resource extraction, trade, and consumption, and how do these patterns influence climate, biodiversity, pollution, and equity outcomes?
- What are the sustainable levels of global natural resource use, and how can science-based targets guide national and international policy frameworks?
- Which policy packages and transition pathways can achieve absolute decoupling of well-being and economic growth from resource use and environmental impact?

Box 4: Institutional Arrangement for IRP Datasets

IRP members have highlighted the importance of clarifying institutional hosting and support arrangements to safeguard the IRP Global Material Flows Database (GMFD) long-term sustainability, enhance its visibility, and ensure that it continues to serve both IRP assessments and wider UN system needs. Discussions have pointed to the value of exploring stronger alignment with UNEP's existing data platforms and initiatives (such as SCP-HAT and the UNEP World Environment Situation Room). This could provide a pathway to more stable institutional support, closer integration with UNEP's data ecosystem, and broader uptake by member States and partners. **UNEP has pledged $250,000 to support the integration of the Global Material Flows database into the UNEP World Environment Situation Room for the 2026-2029 Work Programme (see document IRP.34.15 for more information).**

The 2026–2029 Work Programme will provide the space to further develop these institutional options in dialogue between UNEP, the IRP, and members. Any arrangements agreed for the GMFD could also inform how future datasets – including the proposed Environmental Impacts Database under 'Potential Products' – are positioned to maximize their policy relevance and ensure parity in institutional support.

4.2 HIPA 2: Sustainable Resource Management for effective action on climate change, biodiversity, and pollution

HIPA-2 focuses on identifying and promoting sustainable resource management strategies that can reduce environmental pressures across key provisioning systems and high-impact value chains and sectors, while enabling low-carbon, nature-positive, and socially just transitions.

This HIPA adopts hybrid framing: using provisioning systems to ground systemic thinking, while leveraging sectoral entry points for accessibility and policy traction. Studies under HIPA2 will contribute to more effective and integrated decision making at the global, regional, national and city level. Across all workstreams, IRP will maintain its comparative advantage in integrated assessment, ensuring that studies inform SDG delivery, MEA implementation, and emerging global frameworks as well as providing practical sector level science-based policy options.

HIPA-2 includes two complementary workstreams: Sustainable Resource Management Solutions in Provisioning Systems and Sectoral Linkages, and, Sustainable Resource Management for Resource Efficient and Circular Value Chains.

Table 3: Research Outputs for HIPA-2				
Workstream	**Research Product**	**Type**	**Status**	**Expected Launch date**
Core Priority Products				
Sustainable Resource Management Solutions in Provisioning Systems and Sectoral Linkages	Decarbonizing Global Cities with Environment, Health and Biodiversity Co-Benefits: A Land-Use Linked Multi-Sector Provisioning Systems Approach	Scientific Assessment	Current	2027
	Critical Transition Minerals for Energy, Mobility and Digitalization (Phase I)	Rapid Study	Agreed for Impact (New)	2027
	Critical Transition Minerals for Energy, Mobility and Digitalization (Phase II)	Scientific Assessment	Agreed for Impact (New)	2029
Sustainable Resource Management for Resource Efficient and Circular Value Chains	Advancing the Circular Economy and Consumer Electronic Markets	Scientific Assessment	Current	2026
	Resource Efficient and Circular Economy Strategies for a Sustainable Bioeconomy	Scientific Assessment	Agreed for Impact (New)	2027
Potential Products				
None				

This work will be embedded in HIPA-1 workstreams, especially within the flagship Global Resources Outlook Report where timing allows, to ensure systemic coherence among the HIPAs. Some of the key policy-relevant questions HIPA-2 seeks to inform includes:

- How can sustainable resource management simultaneously advance climate mitigation and adaptation, biodiversity conservation, land restoration, and pollution reduction?
- Which circular and resource-efficient strategies in key provisioning systems (urban, food, energy, and mobility) offer the greatest potential to meet climate, biodiversity, and pollution goals by 2030 and beyond?
- How can critical energy transition minerals and bio-based resources be managed to deliver climate and biodiversity benefits while minimizing land, water, and social pressures?
- Which policies, financial instruments, and governance arrangements are most effective for scaling circular economy transitions and reducing virgin material demand?

4.3 HIPA 3: Sustainable Resource Management for effective action on human health, wellbeing, prosperity, and equity

Current patterns of extraction and use continue to drive inequality, environmental degradation, and health risks, particularly in low-income and resource-dependent communities. These challenges make it increasingly clear that the management of natural resources cannot be viewed in isolation from broader social and economic objectives. Resource use, distribution, and governance are deeply intertwined with questions of justice, health, and dignity. HIPA-3 aims examines the links between sustainable resource management and human development outcomes, including health, prosperity, and equity. It seeks to provide science-based insights that support the integration of resource strategies into broader development agendas and social policy frameworks - particularly in relation to the SDGs, climate justice, and inclusive sustainable consumption and production.

In the 2026-2029 Work Programme, HIPA-3 includes one workstream - Socio-economic/distributional implications of sustainability transitions, under which is included one active product: Socio-economic implications of enhancing resource efficiency and promoting circular economy.

Key policy questions:

- How can sustainability transitions be designed and governed to enhance social justice, equity, and wellbeing, while avoiding new forms of exclusion or inequality?
- What policy and investment strategies can ensure that the benefits and costs of sustainability transitions are shared equitably within and between countries?
- How can low- and middle-income countries leverage circular and resource-efficient strategies to leapfrog toward more inclusive, resilient, and just development pathways?
-

Table 4: Research Outputs for HIPA-3

Workstream	Research Product	Type	Status	Expected Launch date
Core Priority Products				
Socio-economic/distributional implications of sustainability transitions	Socio-economic implications of enhancing resource efficiency and promoting circular economy	Scientific Assessment	Current	2026

4.4 HIPA 4: Enabling sustainability transitions

Systemic changes to the institutions, rules, and incentives that shape production and consumption is needed. HIPA-4 focuses on enabling sustainability transitions through the transformation of economic systems, including financial flows, trade governance, and innovation ecosystems - supporting policy reforms that make resource-efficient, circular, and just transitions possible. Reflecting recent consultations, HIPA-4 will serve as a bridge between the Panel's scientific assessments and the policy, institutional, and economic levers that can scale impact. Across all workstreams, the IRP will apply its strengths in systemic thinking, evidence synthesis, and policy relevance to identify solutions that support the implementation of the SDGs, Paris Agreement, and emerging sustainability frameworks. HIPA-4 will include 1 Core Priority Product, and three possible products.

Possible policy relevant questions the HIPA seeks to address includes:

- How can financial, fiscal, and trade systems be reformed to align global capital flows with sustainable and circular patterns of resource use?
- What governance and institutional arrangements at global, regional, and national levels can most effectively coordinate resource management and ensure fair access and accountability?
- Which combinations of policy instruments and innovation incentives can create enabling environments that accelerate circular, low-impact, and just economic transitions?
-

Table 5: Research Outputs for HIPA-4

Workstream	Research Product	Type	Status	Expected Launch date
Core Priority Products				
Finance, investment and trade system needed for sustainable resource management	Financing, Investment and Trade for Sustainable Resource Use	Rapid Study	Agreed for Impact (new)	2029
Possible Products				
Trade and transboundary resource use	/	/	/	/
Business model, digital & other technological innovations for sustainability transitions	Enabling Policy instruments for Circular Economy Transitions	Rapid Study	/	/
Options for sustainable resource management	Options for Coordinated Resource Governance at Multiple Scales	Rapid Study	/	/
	Resources and Conflicts	Rapid Study	/	/

Box 5: Trade and Transboundary Resource Use

Trade remains a strategically important dimension of global resource governance, with potential to shape circular economy transitions and equitable development pathways. A proposal on *Global Resource Trade for a Circular Economy* was initially advanced, and draft Terms of Reference have been under preparation. In the course of recent consultations, however, members signalled that while trade should remain part of the IRP's analytical lens, a dedicated workstream may not be the most effective use of resources at this stage. The emerging consensus is to integrate trade perspectives into other priority products – and it is therefore now proposed as an integrated product under HIPA-4 *Finance, investment and trade system needed for sustainable resource management*. The IRP remains open to revisit a dedicated product if a clear policy window or partnership opportunity arises.

5. Mobilizing the Best Science-Policy Expertise

The following sections propose strategies to ensure a strong, diverse, and balanced composition of the IRP Panel and Steering Committee.

5.1 Building a strong and diverse Panel

As of October 2025, the Panel has 41 members (including 2 Co-Chairs and 12 new Panel Members on a one-year engagement period). The objective of the IRP Panel membership strategy in 2026-2029 is to continue strengthening and diversifying the global scientific panel. To achieve this, the Secretariat - with support from IRP Panel Members - will periodically review the expertise available and assess gaps considering: (1) ongoing and future research needs, (2) the status of members who have reached the end of their maximum possible terms (12 years); and (3) engagement of members who have reached their maximum term in active working groups. On that basis, the Secretariat will follow IRP Policies and Procedures to recruit new scientists.

By the end of the 2026-2029 work programme, up to 21 Panel members may have reached their maximum term limits and could end their membership with the Panel. Therefore, up to 21 new Panel member positions could become available over the course of the 2026-2029 work programme.[8] While every opportunity will be made to continue to engage Panel Members whose terms have ended in future working groups as relevant, and while their expertise and outreach may be called on to support ongoing IRP activities – this none-the-less heralds a significant change in IRP membership (up to over 50% turnover). The 2026-2029 cycle is therefore a cornerstone cycle to shape an IRP Panel membership that is future fit in terms of its expertise, gender balance and regional representation.

New Panel member recruitments should continue following the principles of ensuring diverse expertise and balanced composition of the Panel; and strengthening the engagement of Panel members. In addition to expertise, a balanced composition of the Panel in terms of geography and gender should continue to be a priority for the 2026-2029 cycle. Of the 41 current panellists, only 14 are women (34%). This is twice the number of female scientists as compared to 2021. Out of the 12 scientists who joined the Panel in 2025, 7 (58%) are women and 7 (58%) come from developing countries.

The current regional breakdown of Panel membership is: 19 from Europe, 12 from Asia and the Pacific, 4 from Africa, 3 from Latin America and the Caribbean, and 3 from North America[9]. While progress has been made, there is still significant room for improvement. The Panel should strive to include more members from the most under-represented regions such as Africa, Asia and the Pacific, Latin America and the Caribbean, and West Asia.

[8] Depending on the engagement of members who have reached their maximum term in active working groups.

[9] Following UNEP's division of regions and countries. There are currently no members from West Asia.

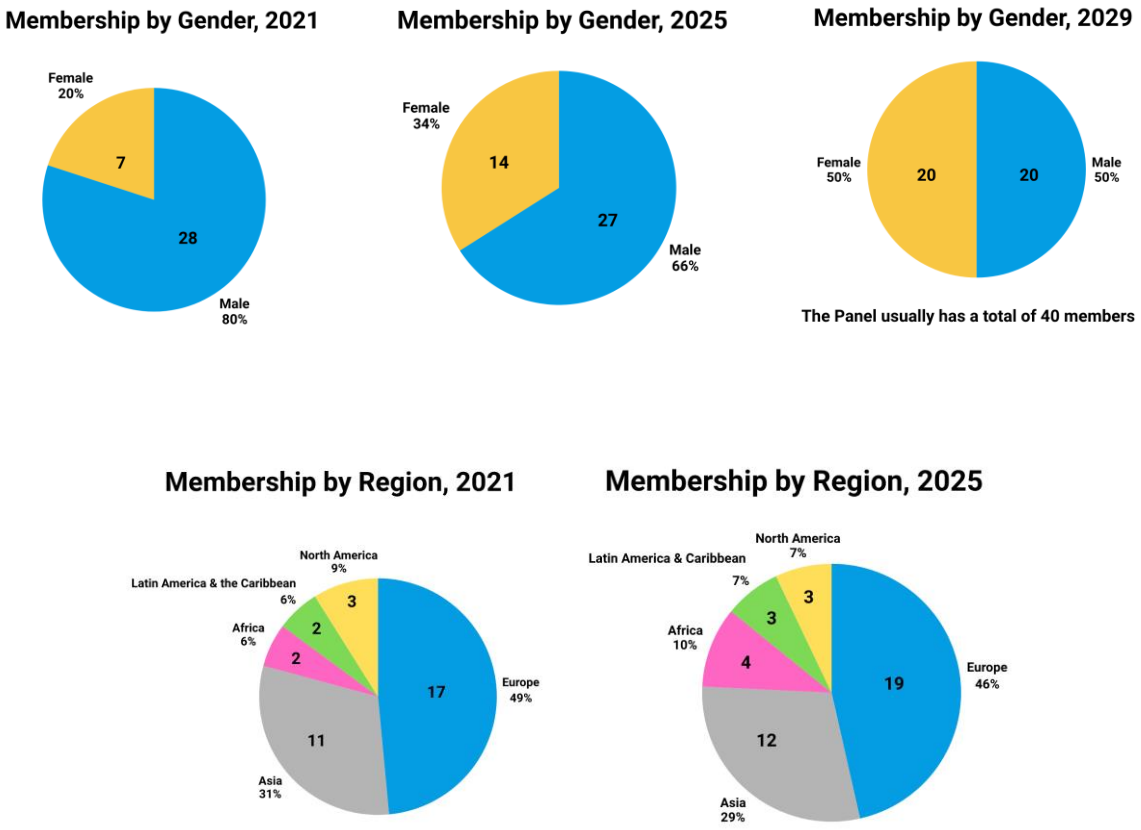


Figure 3: IRP Panel Membership by gender and by region over time.

The targets and action plan to build a strong and diverse Panel are as follows:

Table 6: Targets and action plan to ensure diverse expertise and balanced composition of the Panel

ENSURING DIVERSE EXPERTISE AND BALANCED COMPOSITION OF THE PANEL	
Targets	**Action Plan**
⊙ Match the expertise with the identified high priority areas ⊙ Reach at least 50% female membership among new recruits, and aim for 50% female membership in the Panel ⊙ Reach 50% members from developing countries among new recruits	✓ Periodically review the mapping, in consultation and under the guidance of IRP Panel members, to adjust to emerging needs and plan calls for expressions of interest in advance. ✓ IRP Steering Committee members could consider increasing the total number of Panel members to support regional and gender diversification of the panel. This would have financial resource implications. ✓ Disseminate call for expressions of interest by leveraging the networks of Panel members, former Panel members, Steering Committee, Strategic Partners, UNEP Regional Offices and UNEP Country Offices with a particular emphasis on networks that focus on female scientists. ✓ Disseminate the call for expressions of interest only in the target regions: Latin America and the Caribbean, Africa, and Asia and the Pacific and West Asia. ✓ Targeted outreach to individual scientists who present strong potential for the IRP, in addition to public calls for expressions of interest.

5.2 Strengthening the IRP Steering Committee

The Steering Committee is the governing body of the IRP. The IRP Steering Committee is currently composed of 34 members, including UN Member States, the European Commission (EC) and the United Nations Environment Programme (UNEP); with the last two members acting as the Steering Committee Co-Chairs. Table 7 shows membership and the related coverage of involvement across intergovernmental, regional and other types of platforms. In addition, the IRP engages with representatives from governments who have expressed interest in the IRP but have not yet formally adhered to the Steering Committee. These countries – under the category Steering Committee Observer – are: Angola, Azerbaijan, Democratic Republic of Congo, Israel, Morocco, Poland, Saudi Arabia, Singapore, and the United Kingdom.

Table 7: IRP Country Steering Committee Membership

IRP STEERING COMMITTEE MEMBERS		Intergov. Platforms			Economic / Political unions				International Organizations					
		G7	G20	G77	EU	ASEAN	AFRICAN UNION	ARAB LEAGUE	OECD	ECA	ECE	ECLAC	ESCAP	ESCWA
Europe	Belgium				O				O		O			
	Germany	O	O		O				O		O	O		
	Finland				O				O		O			
	France	O	O		O				O		O	O	O	
	Italy	O	O		O				O		O	O		
	Netherlands				O				O		O	O	O	
	Norway								O		O	O		
	Slovenia				O				O		O			
	Sweden				O				O		O			
	Switzerland								O		O			
Asia & Pacific	China*		O	O									O	
	India		O	O									O	
	Indonesia		O	O		O							O	
	Japan*	O	O						O			O	O	
	Kazakhstan										O		O	
	Philippines			O		O							O	
	Vietnam			O		O							O	
West Asia	Jordan			O				O						O
Latin America and the Caribbean	Argentina		O	O								O		
	Brazil		O									O		
	Chile			O					O			O		
	Costa Rica			O								O		
	Mexico		O						O			O		
	Peru			O								O		
	Uruguay			O								O		
Africa	Ghana			O			O			O				
	Kenya			O			O			O				
	Namibia			O			O			O				
	South Africa		O	O			O			O				
	Tunisia			O			O	O		O				O
North America	Canada	O	O						O		O	O		
	USA	O	O						O		O	O	O	

**Japan and China (together with the Republic of Korea) are also included in ASEAN plus Three.*

To strengthen the IRP Steering Committee, two areas of action are suggested: build a bigger and more diverse SC membership and enhance engagement of SC members. The targets and action plan to strengthen the IRP Steering Committee are as follows:

Table 8: Targets and suggested action plan to strengthen the IRP Steering Committee

BUILDING A BIGGER AND MORE DIVERSE STEERING COMMITTEE	
Targets	**Action Plan**
Strategically expand the SC membership to 45 members especially in under-represented regions including *indicatively*: Three African countries (for e.g. DRC, Nigeria, Zambia, Morocco, Egypt); Two Latin American and Caribbean countries (for e.g. Colombia, Trinidad and Tobago); Two countries from West Asia (for e.g. UAE, Qatar, Saudi Arabia, Kuwait, Oman); Two country from Asia & the Pacific (Thailand, Singapore, South Korea); Two OECD countries (for e.g. Denmark, Luxembourg, the United Kingdom, New Zealand, Australia).	✓ Secretariat to liaise with UNEP (including Governance Affairs Office) and its Regional Offices and relevant UNEP regional or multilateral initiatives (10YFP, PAGE, GACERE) for the identification and mobilization of new SC members. ✓ Co-Chairs, SC, and Panel members support in the identification and mobilization of new SC members. ✓ Secretariat to develop relevant communications materials to support outreach and engagement of new SC members.

Table 9: Targets and action plan to strengthen Steering Committee engagement

STRENGTHENING ENGAGEMENT OF SC MEMBERS	
Targets	**Action Plan**
Ensure active participation of the IRP Steering Committee members in IRP meetings	✓ Induction meeting and onboarding for new SC members. ✓ Convene regular intersessional meetings of the IRP Steering Committee (virtual or in-person as resources allow) ✓ SC members ensure senior representation at biannual IRP meetings. ✓ SC members ensure continuity of representation at IRP meetings and facilitate transition between focal points in the event of changes.
Ensure more proactive engagement in review and discussions of policy relevance of IRP reports	✓ SC members invited to provide input throughout the report development process and in the finalization of Summaries ✓ IRP outputs to provide data at a regional level where resources allow ✓ Secretariat to send meeting documents 4 weeks in advance. ✓ SC members to share ToRs and drafts with relevant units within their Ministry and/or with other Ministries/Agencies as relevant.
Increase the participation of SC members in IRP outreach and dissemination	✓ SC members to identify key regional events and opportunities for dissemination when developing an IRP output dissemination plan. ✓ Secretariat to prepare tailored materials (e.g., PPTs, factsheets, videos) for SC members to use in dissemination. ✓ SC members share IRP outputs with national stakeholders through social media, internal communications, events ✓ SC members within the same region to jointly promote IRP knowledge in regional processes or platforms (e.g., ministerial meetings, ASEAN, African Union). ✓ SC members to inform the Secretariat on how IRP outputs are being used in policymaking at national, regional, or global levels.

6. Mobilizing Financial and In-Kind Support for Effective Delivery

To achieve its desired impact, the IRP must ensure that funding matches ambitions. Figure 4 proposes an indicative rollout of Core Priority Products and Possible Products based on the budget projected for the 2026-2029 Work Programme. This budget is based on historical trends in IRP financing from Steering Committee members and considers that contributions will remain at least stable over the 2026-2029. The cost of research products is based on Annex 4 of the 2022 – 2025 work programme. This includes US$350,000 for a full assessment, US$ 200,000 for a rapid study and US$125,000 for a think piece. This estimate includes all costs of contracting, editing, printing, and working group meetings. The actual cost of IRP assessments and think pieces may differ depending on the scope and nature of the publication. Detailed cost estimates will be added to annual IRP budgets as more information becomes available. For Rapid Studies in the 2026-2029 work Programme, a standard cost of US$175,000 has been applied, considering that any in-person working group meetings could be convened back-to-back with annual in-person IRP meetings, or virtually as necessary.

Rollout of projects is only proposed to begin when it is reasonably expected, based on historical trends, that the full costs of the project can be covered by available budget. This is because the Secretariat cannot begin new research contracts until the full amount of budget is available. Within available budget constraints, all Core Priority Products and two Rapid Study 'Potential Products' are included in the projected rollout below. Table 10 on the following page lists the complete Core priority and Potential Research Products, and their related expected future costs.

Figure 4: Proposal for the rollout of IRP Core Priority Products and Potential Products. The Rocket icon indicated potential launch date.

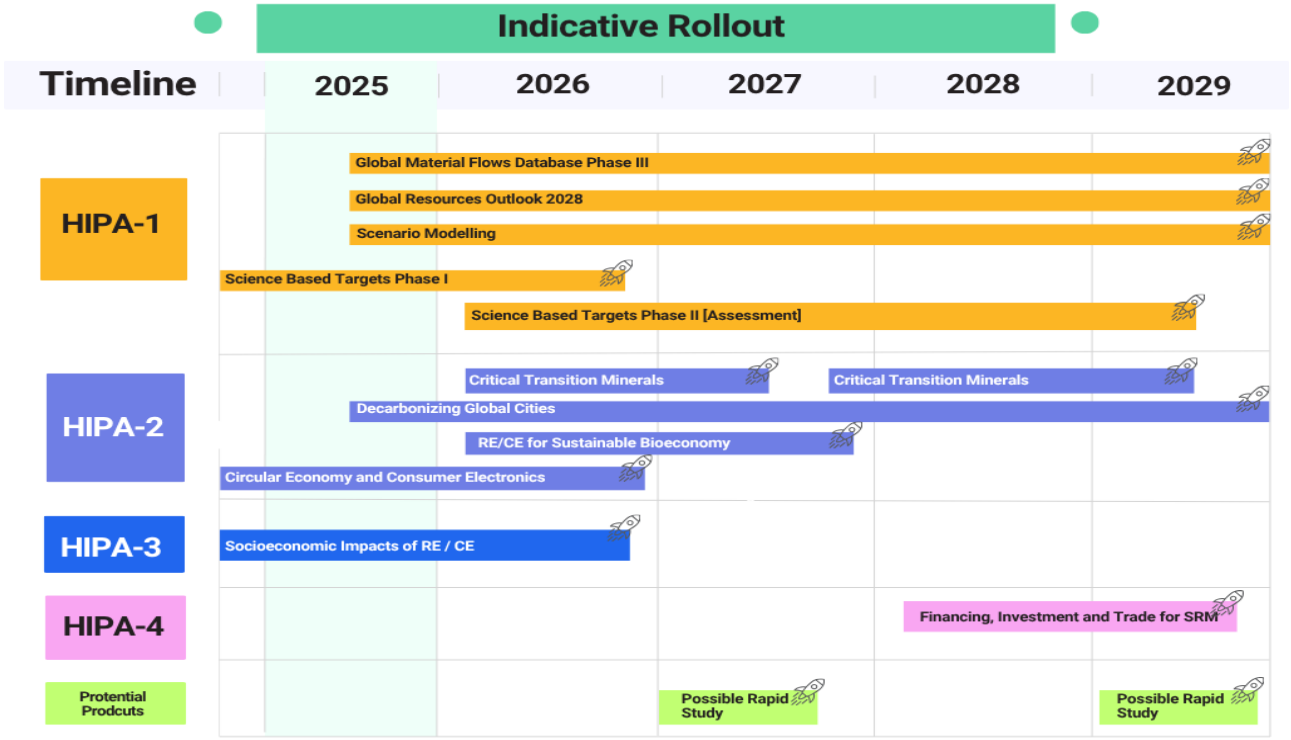


Table 10: Core Priority Products and Potential products Estimated Costs

HIPA	Status	Outputs	Approved budget	Budget for 2026-2029	Type of Product	Totals	Total Funding	Total
HIPA 1	Current Products	• Science-Based Targets (Phase I)	150,000	45,000	Rapid Study	1 x Rapid Study 3 x Scientific Assessment 1 x Flagship Scientific Assessment	$1,591,000	**Core Priority Products: $2,881,000** **Total Potential Products: $750,000**
		• Metrics & data for sustainable resource use (Phase III)	346,000	346,000	Scientific Assessment (Database)			
	Agreed Under Development	• Global Resources Outlook 2028	-	450,000	Flagship Scientific Assessment			
		• Scenario Modelling (incl. for GRO28)	-	500,000	Scientific Assessment (Database)			
	Agreed for Impact (new)	• Science-Based Targets Phase II	-	250,000	Scientific Assessment			
	Potential Products	• Environmental Impacts Database	-	150,000	Rapid Study (Database)	2 x Rapid Study	$300,000	
		• Online Capacity Development Tools and Regionalization	-	150,000	Rapid Study			
HIPA 2	Current Products	• Advancing the Circular Economy in Consumer Electronic Markets (2024)	249,322	45,000	Scientific Assessment	1 x Rapid Study 4 x Scientific Assessment	$1,070,000	
		• Decarbonizing Global Cities	350,000	350,000	Scientific Assessment			
	Agreed for Impact (new)	• Critical Transition Minerals Phase I	-	175,000	Rapid Study			
		• Critical Transitions Minerals Phase II	-	250,000	Scientific Assessment			
		• Resource Efficiency and Circular Economy for a Sustainable Bioeconomy	-	250,000	Scientific Assessment			
	Potential Products	-	-	-	-	$0	$ 0	
HIPA 3	Current Products	• Socioeconomic Implications of Enhancing Resource Efficiency and Promoting Circular Economy (2023)	285,000	45,000	Scientific Assessment	1 x Scientific Assessment	$45,000	
	Potential Products	-	-	-	-	$0		
HIPA 4	Agreed for Impact (new)	• Financing, Investment and Trade for Sustainable Resource Use	-	175,000	Rapid Study	1 x Rapid Study	$175,000	
	Potential Products	• Options for Coordinated Resource Governance at Multiple Scales	-	150,000	Rapid Study	1 x Rapid Study	$450,000	
		• Enabling Policy Instruments for Circular Economy Transitions	-	150,000	Rapid Study	1 x Rapid Study		
		• Resources and Conflicts	-	150,000	Rapid Study	1 x Rapid Study		

Table 11 below presents the products that could be produced in 2026-2029 based on historical income projections.

Table 11: Research products proposed for 2026-2029

HIPA 1	HIPA 2	HIPA 3	HIPA 4
CORE PRIORITY PRODUCTS			
1 x Raid Study 3 x Scientific Assessment	1 x Rapid Study 4 x Scientific Assessment	1 x Scientific Assessment	1 x Rapid Study
POTENTIAL PRODUCTS			
1 x Rapid Study	-	-	1 x Rapid Study

Based on historical contributions from IRP members, total expected income between 2026-2029 is approximately US$7.6 million. It is expected that approximately US$1.9 million will be carried over from the 2022-2025 work programme (of which approximately US$1.2 million is earmarked funding for Current Products and Operations under the European Commission DG Research and Innovation grant to the IRP from 2025-2027; and of which approximately US$200,000 is short term funding to be expended by 2026).

The total estimated cost for the 2026-2029 Work Programme research outputs currently included in the work programme – including Core Priority Products and two Rapid Study Potential Products – is estimated at US$3.2 million.

Under the category of Core Priority Products, 'Current Products' - that is, projects which the IRP has already started and are carried over from the 2022-2025 work programme, or work that has approved TORs – are estimated at over US$800,000. Of these, it is expected that about US$550,000 will be incurred in 2025 to develop the Global Material Flows Database Phase III and the Scientific Assessment on Decarbonizing Global Metropolitan Areas. [10] The rest of the costs (estimated US$250,000) are related to production and publication of the 'Current Products'.

'Agreed Products Under Development' – that is, where TORs are reasonably expected to be approved, and especially the GRO28 and Scenario Modelling TORs – are estimated at US$950,000 over the 2026-2029 period.

New 'Agreed for Impact 2026-2029' products are estimated at US$1,100,000 over 2026-2029.

If all Potential Products were produced, the total cost would be US$750,000. Under current budget forecasts, it would be possible to fund US$300,000 of Potential Products in 2026-2029.

[10] Both products are funded under the European Commission DG Research and Innovation contribution agreement to the IRP.

An estimated total of US$6.3 million will be required to cover for operational costs[11] of the IRP in 2026-2029.

It should also be noted that in 2022-2025, the IRP benefitted in-kind from an agreement between the SUN Foundation and Systemiq, which has supported (in-kind) Secretariat functions, as well as the primary functions of one IRP Panel Co-Chairs. This agreement, and the financial support it benefitted from, ends in 2026 or soon thereafter.

With an expanded budget envelop, the IRP could foresee delivery on all Core and Potential Research products. In addition, the IRP could dedicate resources to developing and delivering products tailored to specific audiences, or multi-media and communication assets to elevate the reach of IRP impacts. Increased ambition related to audience engagement, especially related to activating the IRP Strategic Partnership network, requires dedicated resources and financing beyond what is possible within the current budget envelop. To mitigate any financial risks, and to amplify and elevate the impact of the 2026-2029 IRP Work Programme, the IRP should increase its regular donor base and mobilize more diverse and stable sources of funding.

Hence, Resource Mobilization is a critical aspect of the 2026-2029 work programme to enable expanded ambition and impact of the IRP. The main target sources of funding for 2026-2029 will be Steering Committee members and Strategic Partners. Other potential donors include foundations and private sector organizations, national development organizations in partnership with relevant IRP Steering Committee members, or joint-fundraising with IRP Panel members by identifying relevant 'calls for proposals' that may support the IRP work programme delivery.[12]

In addition, Steering Committee members may consider supporting a reduced expected IRP operational cost by, for example, secondment or Junior Professional Officer positions to support the IRP Secretariat, self-funding or supporting Panel member travel to outreach or IRP meetings, hosting of IRP in-person meetings, or supporting research communications and outreach, including through translations, by in-kind contributions among others.

6.1 Mobilizing resources from Steering Committee members and Strategic Partners

As per articles 9 and 10 of the IRP Policies and Procedures, SC members from OECD countries **shall** provide annual financial contributions to the IRP, while SC members from non-OECD countries shall strive to provide these. Non-earmarked, multi-year financial contributions are strongly encouraged as they will facilitate effective and timely implementation of the Work Programme. Both OECD and non-OECD SC members are also encouraged to provide in-kind contributions to the IRP.

The majority of current IRP funding comes from the European Commission (a multi-year contribution agreement with DG Research and Innovation which covers between 55 - 62 per cent of the total IRP income between 2026-2027). Of the total 16 OECD members of the IRP Steering Committee, five IRP

[11] The operational costs include secretariat staff salaries, travel and meeting logistics, general communications and outreach including website maintenance and regional activities, capacity building, project evaluation and the mandatory coordination levy to support the UN Resident Coordinator system and programme support costs.

[12] 'Other potential donors' refers to any stakeholder who is not a Steering Committee member but who could be approached for funding in accordance with this work programme.

OECD Steering Committee members contribute over US$100,000 each per year. Five other IRP Steering Committee members contribute under US$100,000 per year (between US$45,000 - US$70,000). Six OECD Steering Committee members do not make annual financial contributions to the IRP.

If all current IRP OECD members contributed annually US$100,000, and members who contribute above that amount maintain their annual contribution levels, then the projected IRP income for the 2026-2029 Work programme period would be US$11 million, that is - an additional US$3.4 million from current projected levels).

Resource Mobilization Efforts by UNEP: Based on extensive consultations with UNEP Senior Management and the IRP Co-Chairs and membership, in addition to mobilizing in-kind support from existing UNEP staff and expertise, UNEP has pledged to support the staff salary of the P-5 Position within the IRP Secretariat (estimated at approximately $200,000 per year), and, to allocate $250,000 to support the integration of the Global Material Flows Database to the UNEP World Environment Situation Room (WESR). These funds have not yet been integrated into the IRP Financial Projections and would be in addition to budget projections presented here as appropraite. Please see IRP.34.15 *UNEP Management Response to International Resource Panel Strategic Review and Steering Committee Asks_Revised* version for the full proposals by UNEP.

The proposed targets and actions to mobilize resources from the Steering Committee and Strategic Partners in 2026-2029 are as follows:

Table 121: Targets and actions to mobilize resources from the Steering Committee and Strategic Partners

MOBILIZING RESOURCES FROM THE STEERING COMMITTEE MEMBERS AND STRATEGIC PARTNERS	
Targets	**Action Plan**
⊙ Increase overall financial and in-kind contribution from current Steering Committee members and Strategic Partners. ⊙ Increase compliance rates of financial obligations from OECD members. ⊙ Expand the donor base. ⊙ Increase non-earmarked financial contributions to represent majority of annual contributions	- SC members from OECD countries shall provide financial contributions which, wherever possible, will be non-earmarked and in multi-year grant agreements. Transparency about contributions and due acknowledgement of donors will be ensured by the IRP Secretariat. - OECD members shall strive for a minimum contribution of $100,000 or more per year. - IRP SC Members to investigate earmarking/directing funds to the IRP from contributions to UNEP (for example to the Environment Fund) - SC and Panel members and Co-Chairs support the Secretariat to increase the membership base with additional OECD members and other developed countries who could provide a financial contribution. - Encourage SC members from non-OECD, but also from OECD countries to provide at least one in-kind annual contribution. These could include: o secondment of staff to support the IRP Secretariat, or Junior Professional Officers to support Secretariat functions o pro-bono staff-time dedicated to IRP activities or to develop outreach materials (e.g., MOOC, infographics, video). o Translation of IRP materials o Fund travel of their SC representative to attend IRP meetings o Integrate IRP findings, data, and methods in national or regional scientific studies and assessments.

	○ Organize or support the organization of national or regional events. ○ Organize or support the organization of IRP working group meetings (with back-to-back country dialogues or capacity building events). ○ Fund travel and accommodation of IRP members to attend dissemination or capacity building meetings. - Stronger engagement and alignment with UNEP Governance Affairs Office and the UNEP Regional Offices to facilitate introductions to relevant representatives from member states to join the IRP Steering Committee - Regular presentations on the IRP at the Committee of Permanent Representatives of UNEP meetings.

6.2 Mobilizing resources from other donors

The IRP will continue to approach "Other Donors", that is, donors who are not Steering Committee members or Strategic Partners. This group includes foundations, thematic coalitions, as well as initiatives of private-public sector collaboration (e.g., Climate and Land Use Alliance, Food and Land Use Coalition, International Climate Initiative, Circular Cars Initiative of World Economic Forum) and private sector platforms like business coalitions or associations (rather than individual companies).

In addition, Steering Committee members are invited to facilitate contact with national international policy, science or development organizations with whom the IRP could partner. Panel members are invited to consider partnering with the International Resource Panel in developing applications for grant funding to support the research development functions of the IRP.

When providing contributions to the IRP, Other Donors could request:

- Acknowledgement on the IRP website or IRP reports according to IRP Logo Guidelines.
- Updates on the IRP report progress through regular line of reporting.
- Use of IRP logo on its own communication material if authorized and in accordance with IRP Logo Guidelines.

To safeguard the IRP's independence and credibility, the following boundaries must be explicitly mentioned when approaching potential private sector donors:

- The Donor will not participate in the decision-making process of IRP publications.
- The Donor must consult with the IRP Secretariat before displaying the IRP name or logo on any publication or material (online or physical).
- Funding must remain below threshold set by IRP Policies and Procedures and should be approved by the Steering Committee Co-Chairs. The contribution should not imply interference with the report development process.
- Total transparency is required regarding support (financial or in-kind).

Support from Other Donors could include:

Table 13: Support from other IRP donors

SUPPORT		EXAMPLES
Financial		▪ Contribution to fund overall implementation of the 2026-2029 Work Programme; and IRP scientific studies and assessments ▪ Co-development of new scientific studies and assessments, including with national scientific organizations. ▪ Development of section/chapter to complement a report/scientific study/ assessment published by the donor. ▪ Preparation of national and regional scientific studies and assessments based on the IRP global assessments. ▪ Dissemination of IRP findings via regional and national capacity development activities
In-kind	Staff	▪ Dedicated human resources to support the work of the IRP work (Junior Professional Officers, secondment positions within the Secretariat)
	Logistical support	▪ Provide venue, catering, travel for the IRP events
	Dissemination	▪ Dissemination of IRP findings through online platforms and publications, invitation of IRP speakers
	Data	▪ Access to proprietary database for further development by the IRP

The targets and actions to mobilize resources from Other Donors in 2026-2029 are:

Table14: Targets and actions to mobilize resources from other donors

MOBILIZING RESOURCES FROM OTHER DONORS	
Targets	**Action Plan**
✓ Approach at least 15 potential Donors by 2027 ✓ Obtain funding from at least 2 Donors	The IRP Secretariat to: ✓ Prepare a dedicated resource mobilization strategy (pending resource availability) and prepare a document tailored to each donor with a list of practical options to contribute to the implementation of the 2026-2029 IRP Work Programme and/or development of new scientific studies and assessments. ✓ Test practical options and assess effectiveness ✓ Create a close collaboration with UNEP's private sector unit, maximize synergies and increase visibility for the mobilization of funds

7. Monitoring our Success

Progress on the implementation of this Work Programme will be presented by the IRP Secretariat at every biannual meeting of the IRP, following the templates developed for the 2022-2025 work programme which are included in **Annex 3.**

Annex 1. Approved TORs

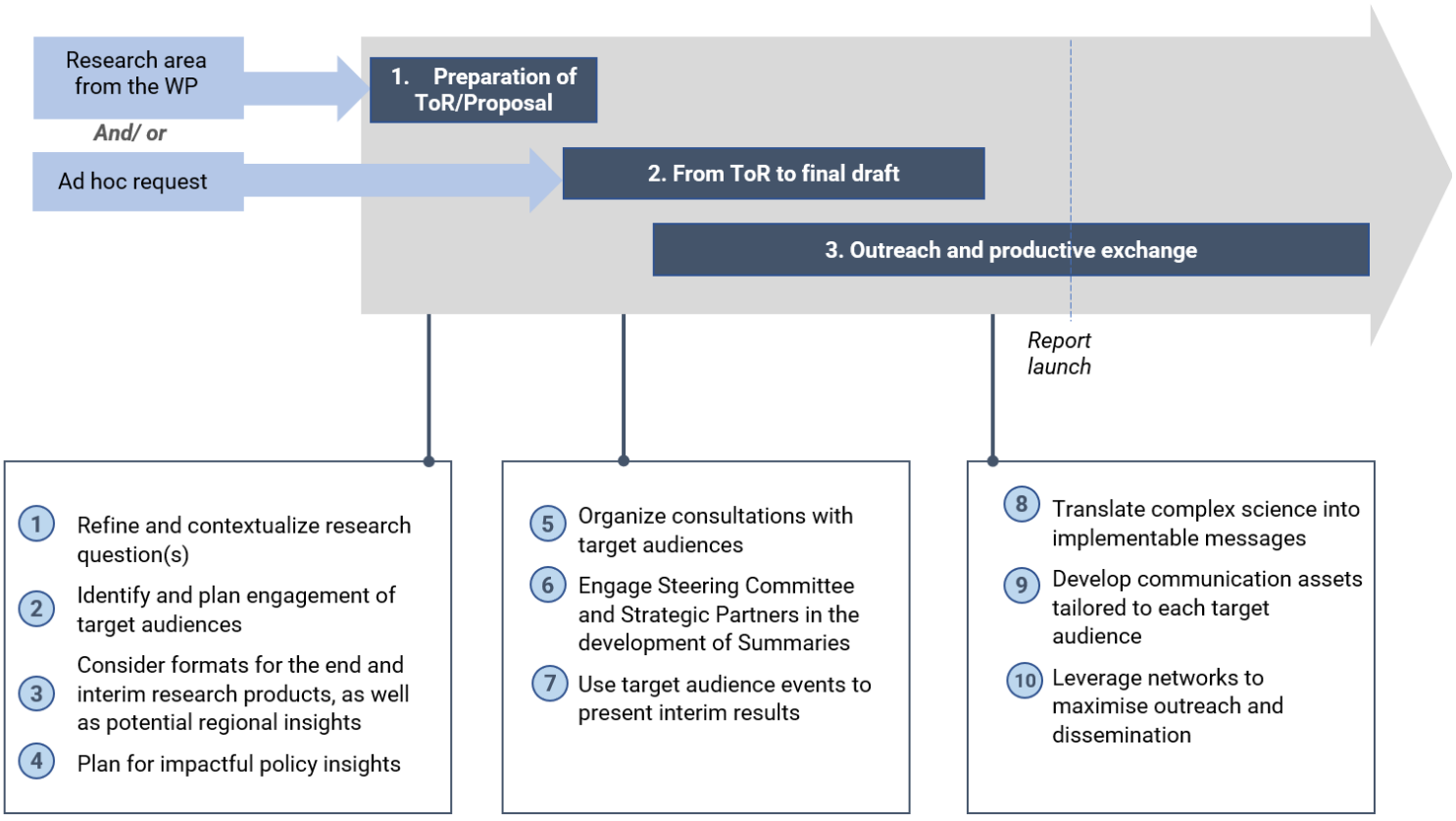
Please refer to document IRP.34.08.02

Annex 2: Elements for increased policy impact

4.5.1 Ten principles to guide the development of IRP outputs

The following 'Ten principles for Impact' will guide writing teams and the Secretariat when developing an IRP scientific publication from the development of Terms of References (ToRs) or proposals to outreach. These guidelines, developed for the 2022-2025 work programme, will ensure relevance for target audiences and a clear strategy for outreach and impact.

Figure 1: Ten principles for *i*mpact



Preparation of ToRs or Proposal

Principle 1: Refine and contextualise. When developing ToRs, writers should refine policy relevant questions considering emerging science and policy context at the time. *Has there been any recently published reports or research in progress on the topic that could lead to a change of scope? Is the question being covered by/related to other findings of other work of the IRP? Has there been any recent socio-political events that could lead to a revision of the question or make it particularly timely? When the scientific publication is complete, what processes and events could it influence?*

Principle 2: Identify and plan engagement of target audiences. Each TOR approved should include a dedicated Communications and Outreach strategy, or indication of the resources to be dedicated to develop the strategy. Identified target audiences for a given research work can be included in the research development process at certain key moments of the report development to provide their feedback on ToRs or drafts.

Principle 3: Outline format for outputs, identify interim products, and consider potential regional insights. The format of IRP outputs as well as potential regional or context specific insights from the research and proposed interim products should all be identified from the beginning of the report development process to align data collection, methodology, budget, and timeline.

Principle 4: Plan for impactful policy insights. Consider carefully how the new research will inform policy action and the type of insights it will generate. Consider the audiences that need to be engaged in advance of the launch in order to develop a appetite for the report and its findings, and therefore maximize the impact of its uptake at launch. Iterative and interim results sharing can help to build a community of active supporters for the IRP recommendations to be released.

Submission of ToRs: To incorporate the first four Principles, when submitting new ToRs, the proposing IRP member(s) must synthesize in a few sentences how the proposal reflects each of the following:

- ✓ **Relevance**: The work responds to a direct policy need or emerging policy priority, and contributes to the IRP Vision for Impact in 2026-2029 including its objectives and desired outcomes. These are clearly demonstrated in the TORs.
- ✓ **Impact**: There is a high uptake potential for the policy-relevant recommendations, the work delivers a unique value-addition to the field without duplicating on-going efforts inside and outside the IRP.
- ✓ **Expertise Fit**: The work builds on the IRP's comparative advantage, and the IRP has or can mobilize expertise needed to deliver within the proposed timeline.
- ✓ **Feasibility**: The proposal is clearly defined by product type, and is feasible with IRP budget and resources.
- ✓ **Scientific Rigour**: The proposal is based on a strong methodological foundation that can withstand an external peer review where required.
- ✓ **Communicability**: The target audiences are clearly identified and in line with the IRP Audience Engagement Strategy for 2026-2029, a communications strategy is integrated from the outset and the findings can be packaged in a meaningful way to reach target audiences.

The Secretariat will confirm whether the IRP has or can mobilize funding needed to deliver outputs within the proposed timeline.

Drafting IRP reports

Principle 5: Organize consultations with Primary Audiences. The Primary Audiences identified in the preparation phase can bring a unique perspective to the Working Group. Consultations with the users of IRP knowledge can help shape a product that is understood and applied by target audiences.

Principle 6: Ensure production of high-quality IRP Summaries for Policymakers. Steering Committee members and Strategic Partners could be asked to help refine messages included in the Summary for Policymakers or Summary for Business Leaders, based on the scientific recommendations included in the main report. In the preparation of these summaries, the Secretariat could engage support from professional science communicators. The Steering Committee should be provided sufficient time to review the document and a space to discuss it (for example, through an online meeting with lead authors).

Principle 7: Use target audience events to present interim results. Lead authors could present some emerging results at dissemination events of the priority target audiences identified in the ToRs/proposals. This can help collect feedback from audiences on emerging messages and adjust or strengthen the research during its final stages of drafting.

Outreach and dissemination

Principle 8. Translate complex science into actionable messages. Simplicity and specificity in the narrative and key facts increases the likelihood that key insights are adopted by target audiences and easily interpreted by policymakers. Any key message coming from the IRP must be under-pinned by peer-reviewed science yet must be presented in a way that is understandable and memorable for these audiences (e.g., clear, concise, plain English). The way the science is formulated will support the easy translation of the information, for example by offering more specific policy recommendations or by focusing the analysis. Support from professional science editors should be considered to ensure the effective implementation of this principle.

Principle 9. Develop tailored communication outputs. Tailored packages of information will help increase uptake of IRP reports. Translations to all UN languages, regional segregation of information, short briefs for policymakers are an essential part of the communications package developed for IRP reports. Shorter products are preferred as more easily digestible for policymakers.

Principle 10. Leverage networks to maximize outreach and dissemination. Lead authors should work with the Secretariat to connect with IRP Strategic Partners, Steering Committee members, Panel Members, IRP Co-Chairs and UNEP to leverage their networks for optimal outreach of scientific publications. Other approaches could include the submission of IRP research in peer-reviewed journals, interviews with journalists and other actors in the 'science communications' community and partnering with private sector partners

Annex 3: Work programme Monitoring

Progress on the implementation of this Work Programme will be presented by the IRP Secretariat at every biannual meeting of the IRP.

Table 12:Monitoring success: engaging more and better with IRP audiences and stakeholders

Engage more and better with IRP audiences and stakeholders		
Category	**Main achievements in the past 6 months**	**Next steps**
Regional and National Governments (IRP Steering Committee members and other governments)	- Indicate regional/national policy plans/strategies that utilise IRP's work - Indicate capacity development toolkits, courses and/or workshops organised. In the case of a workshop, specify the context, potential partners, type of audience and number of participants and conduct a post- training assessment measuring knowledge and skills of participants	
Intergovernmental Platforms/For a (E.g., UN High Level Political Forum on Sustainable Development (HLPF), UN Environment Assembly (UNEA), Group-of-Seven (G7), Group-of-Twenty (G20), Group of 77 (G77), Intergovernmental Panel on Climate Change (IPCC), Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES))	- Report on key engagement activities with selected audience and their impacts	
Economic/ Political Unions (E.g., EU, ASEAN, African Ministerial Conference on the Environment, African Union, Council of Arab Ministers Responsible for the Environment (CAMRE), Forum of LAC Ministers of Environment)	- Report on key engagement activities with selected audience and their impacts	
Other stakeholders of the IRP (E.g., academic networks/think tanks, international organizations, multi-stakeholder platforms, civil society organizations and youth organizations)	- Report on key engagement activities with selected audience and their impacts	

Table 2:Monitoring success: developing policy-relevant science

Developing policy-relevant science						
HIPA	**Work Stream**	**Status**	**Next steps**	**Information products**	**Dissemination**	**Impact**
1		*Status of the report development process.* *- TORs (Under development / submitted for comments / submitted for approval / approved on DD/MM/YY)* *- 1st draft/peer review/second draft (Include number of persons who provided inputs (distinguishing by Panel and Steering Committee where relevant))* *-Ready for publication (expected date)*	*Next steps for the work stream*	*Information products developed to disseminate the findings of the work stream (e.g., summaries for policymakers, factsheets, videos, etc.)*	*Has any dissemination / awareness-raising taken place? In what context and to what audiences? Include information on:* *- Number of media clippings per launch event* *- Audience engagement activities, launches, and promotional/awareness-raising events*	*Is there any impact at this stage? Has the work stream influenced any policy process, corporate policy, etc?*
2						

Table 3: Monitoring Success: mobilising the best science-policy expertise

Mobilising the best science-policy expertise			
Targets/Strategic Actions	**Status**	**Main achievements past 6 months**	**Next steps**
Ensuring diverse expertise and balanced composition of the Panel			
Strategically expand the Steering Committee membership base keeping in mind the need to strive for an inclusive and balanced SC membership			
Ensure active participation in the IRP of all SC members (including active attendance to IRP meetings and the provision of inputs to existing and emerging work streams)	- If possible, include number of SC members having attended the previous 2 IRP meetings and number of members taken the floor - If possible, include number of SC members having provided written comments to draft reports		
Increase the participation of SC members in IRP outreach and dissemination	*- Description of status* *- If relevant, succinctly mention the Steering Committee's role in activities relating to information products, dissemination, and impact for the HIPAs above*		
Increase contributions (financial and in-kind) from current SC members and reactivate financial engagement of members	*- If possible, include level of contributions of current year vs. previous year* *- If possible, include number of OECD countries having provided financial support*		

Table 4: Monitoring Success: resource mobilization

Resource Mobilization			
Category	**Targets/Strategic Action**	**Status/ Main achievements in the past 6 months**	**Next steps**
	Increase overall financial and in-kind contribution from current Steering Committee members and Strategic Partners.		
	Increase compliance rates of financial obligations from OECD members.		
	Expand the donor base.		
	Increase non-earmarked financial contributions to represent the majority of annual contributions		
Other donors	Approach at least 15 potential Donors by 2025		
	Obtain funding from at least 2 Donors		

III. Approved Terms of Reference

I. ToRs “Metrics, Data and Indicators for Sustainable Resource Use (Phase III) [Pg. 52]

II. PROPOSAL FOR THE DEVELOPMENT OF AN IRP SCIENCE-BASED TARGET STRATEGY
TERMS OF REFERENCE for a Rapid Study and Assessment [Pg. 72]

III. TERMS OF REFERENCE IRP Report on: Advancing the Circular Economy in Consumer Electronic Markets [Pg. 89]

IV. Terms of Reference: “Decarbonizing Global Cities with Environment, Health and Biodiversity Co-Benefits: A Land-Use Linked Multi-Sector Provisioning Systems Approach [Pg. 107]

V. Terms of Reference for the Study proposed to IRP on “Socio-economic implications of enhancing resource efficiency and promoting circular economy” [Pg. 118]

International Resource Panel – Meeting Document

Doc: IRP/32/07 ToRs "Metrics, Data and Indicators for Sustainable Resource Use (Phase III)"

Date: 29.11.2024

Status: For approval (Panel and SC)

Title: Terms of Reference: "Metrics, Data and Indicators for Sustainable Resource Use (Phase III)"
Abstract: At the 31st IRP Meeting, Members welcomed the proposal to develop terms of reference to update and expand the Global Material Flows Database. The Lead Author was invited to submit Terms of Reference.
References: IRP Policies and Procedures: *73.b. Terms of reference. Panel Members prepare, with the support of the Secretariat, terms of reference (hereinafter ToRs) for scientific studies and assessments according to the Work Programme. The ToRs will include the following elements: purpose, relation with the IRP objective and strategy of the corresponding cycle, scope, structure, urgency, complexity, existing knowledge base, policy relevant questions, added value, available expertise, scale of potential impact and beneficiaries, proposed Lead Authors, financial and team requirements, work plan including timeline, outreach and dissemination. The Panel and/or Steering Committee may request, as appropriate, a more detailed scoping study to further assess the existing knowledge base and added value of the study. The ToRs are submitted to the Panel and Steering Committeefor review and approval.*

TERMS OF REFERENCE

Metrics, Data and Indicators for Sustainable Resource Use (Phase III)

Scientific publication category: (Global Resources Outlook)

Cover Page

Criteria	How the proposal satisfies the criteria
The following sections to be completed by the ToR submissioner(s)	
The proposed policy relevant questions are clear, solutions-focused and in line with the 2022-2025 IRP Work Programme (theory of change, engagement strategy, HIPAs, etc.)	This proposal addresses implementation of the first project listed under "HIPA 1. Current trends and future prospects for global resource use and Sustainable Resource Management" i.e. *Expansion of the IRP Global Material Flows Database (ongoing),* with the addition of policy-relevant information requested by the IRP at its 30th and 31st meetings.
The IRP has or can mobilize expertise needed to deliver within the proposed timeline.	CSIRO has demonstrated its capacity to deliver on earlier iterations of the GMFD for the IRP multiple times in the past. In preparing this TOR CSIRO has ensured it has adequate capacity available, either in-house, or via sub-contracting, over the period specified.
There is a specific and timely need for this work, and it does not duplicate on-going efforts from the IRP or other international scientific bodies.	The timelines for delivery have been designed in accordance with the current 2022-2025 IRP Work Programme, as well as the next iteration of the Global Resources Outlook (GRO) planned for 2028. There is no near analogue of the GMFD, and so no substitute for GRO work, established or in preparation, known to those preparing this document. Beyond that, regular updates of the GMFD are also required for the Sustainable Consumption and Production Hotspot Analysis Tool (SCP-HAT), the Global Footprint Tool, for reporting of SDG indicators 8.4 and 12.2 (and contribute to UNEP's reporting on SDG 12.5 in the future) and the SEEA data initiative contribution of the UNEP. Many of these processes rely on yearly updates.
The work has strong linkages with other work undertaken by the IRP in the current cycle.	The GMFD is a key resource of the policy and decoupling analysis of the IRP and has been the backbone of multiple reports in the past. Maintaining the GMFD in future is critical for informing the ongoing IRP work dealing with analysing decoupling trends, achieving sustainability targets, and identifying policy options relating to resource use, so chiefly under HIPA 1. The expansion into outputs will extend its utility here.

The target audiences and dissemination opportunities are clearly identified and in line with the IRP Audience Engagement Strategy for 2022-2025.	Since 2016, the GMFD has been a key flagship output of the IRP, serving multiple audiences, including the G7 resource efficiency initiative, the G20 resource efficiency dialogue, the monitoring of Sustainable Development Goals, and the development of science-based, data-informed policies, especially in the global South, among other users. The GMFD's numerous opportunities as a crucial resource for the IRP's impact pathway align with the current audience engagement strategy for 2022-2025. The growing interest from UNEP offers a more prominent platform for the GMFD, increasing its recognition as the main authoritative dataset on global resource use and enhancing the policy impact of the IRP.
The work will be presented at a strategic moment with potential policy impact, as per the 'Vision for Impact in 2022-2025' chapter of the work programme.	As described above, the GMFD has been the backbone of the IRP's scientific assessments since 2016, as well as of other UNEP tools informing SCP policies, namely the SCP-Hotspot Analysis Tool and the forthcoming Global Footprint Tool. Following the successful release of GRO 2024, the escalating triple planetary crises, and companies' increasing interest in material flow data, the GMFD is expected to gain popularity among policymakers and the business community. The efforts of many countries to transition to a net zero circular economy will be informed by the GMFD, which will feature new indicators for waste management and resource recovery in a circular economy. This presents a significant opportunity for policy impact for the IRP, supported by the rich data resources provided by the GMFD.
The following elements are clearly outlined: final output(s), interim products, timeline and potential regional insights.	The core outputs will be 1) two updates to the existing GMFD which extend the time series and replace earlier projected data with observed data, and 2) extension of GMFD into initial coverage of key material outputs (emissions and waste), material balancing items, and derived indicators relevant to the circular economy. Good coverage of the output side of material flows will position the IRP in the measuring circular economy landscape.
The following section to be completed by the Secretariat	
The IRP has or can mobilize funding needed to deliver within the proposed timeline.	IRP Steering Committee to approve budget allocation, and work to be funded subject to funding availability.

1. Background and context

[Describe the background, rational, urgency, and complexity of the study]

The Sustainable Development Goals represent an ambitious aspiration for all nations to achieve improvements in human wellbeing and increase the standard of living of all people and countries in an inclusive way (Griggs et al., 2013). It is important that those SDG aspirations rest upon sound management of natural resources. They will require ambitious policies aimed at decoupling economic activity from environmental pressures and impacts while improving human wellbeing outcomes.

The IRP's existing Global Material Flows Database (GMFD), UNEP-IRP (2022), is vital for enabling most countries to measure their progress against important key "hard" physical indicators under the Sustainable Development Goals (SDGs) i.e. SDG goals 8 (target 8.4) and 12 (target 12.2).

It has been envisaged since the 2021 update of the GMFD that to remain sustainable over the long term, the database must move towards a model where individual countries prepare and report their own material flow accounts. To that end, limited studies on integrating individual MFA accounts into the GMFD, from the few nations which prepare their own accounts, were reported on in (Lutter,

Giljum, & Lieber, 2021). This study took place in parallel with the 2021 update.

Since that time, the infrastructure required for nations more generally to prepare their own material flow accounts received a major boost, with UNEP commissioning a major set of online learning materials and tools on the topic, hosted at UNEP (2023). The process of building capacity within national statistical offices (NSOs) globally, to effectively use these resources to construct and report their own material flow accounts, is however still at an early stage.

Furthermore, while UNEP is building a facility for individual NSOs to prepare their own consumption-based indicators (those based on raw material equivalents (RME), such as Material Footprint at the time of writing), maintaining good RME accounts must remain centralised to a large extent. This is due to the dependence of any individual country's account on the quality of the accounts of all countries it trades with.

Continued, centralised preparation of the GMFD from national statistics available in international databases, will thus remain necessary for a number of years yet, to monitor progress against the SDG indicators, as an initial basis for comparison as individual NSO prepared MFA accounts increasingly come online, and for the preparation of RME based indicators.

To remain relevant in this role, the GMFD needs to be updated regularly, preferably annually, and link these updates to the other UNEP tools that rely on such data.

The increasing prominence of issues around waste management and the Circular Economy also strongly suggests the scope of the GMFD must expand. Economy-Wide Material Flows Accounting (EW-MFA), upon which the GMFD is based, outlines a coherent framework within which to reconcile material stocks and flows more generally.

The GMFD currently only deals with flows from the environment to the economy, and between different economies, but provides a logical basis to expand into accounts of material stock accumulation in economies, and outputs of waste to the environment. Maintaining the quality of stocks, as opposed to simply managing flows, is a key feature of the circular economy and more advanced concepts such as the performance economy (Stahel and Clift 2016); hence, this expansion of the GMFD is potentially game-changing in expanding the attention of resource management to considering stocks and flows. The comprehensive coverage of outflows including solid and liquid waste and emissions, and recycling flows, builds the basis for indicators that measure the circularity of the economy.

Extension into these areas would be immediately relevant for UNEP's monitoring progress against SDG Target 12.5. This is an area where limited case studies were undertaken in parallel with the 2021 GMFD update, in Eisenmenger and Haas (2021); (Schandl & Miatto, 2018), and where the capacity of the collaborating institutions which produce the GMFD has advanced in the interim.

Note: The conclusions of 31st Meeting of the International Resource Panel state that the maintenance and expansion (including waste and emissions) of the Global Material Flows Database (GMFD) must be a priority (see 31IRP Meeting Conclusions, Session 15). It notes that the GMFD has been important for national level decision making, especially in developing country contexts.

2. Purpose and objectives

[Specify the purpose and objectives of the research]

The purpose of the scope of work suggested would be twofold. Firstly, to maintain the relevance and utility of the GMFD as the authoritative publicly available source of international material flows data at a national level. Secondly, to extend its relevance in the areas of waste management and the Circular Economy. This can include estimates and imputed numbers for informal activities in the economy such as subsistence agriculture, the grey economy, and informal waste collectors and can be based on methodology developed in the context of GLORIA and SCP-HAT.

2.1 Data updates and integration of national accounts (SDG Targets 8.4 and 12.2)

To serve the first aim the existing accounts must remain current, preferably continuing the data time series right up to the year of release. This is important for it to continue as the base data for high profile reports such UNEP's Global Resources Outlook series, the Global Waste Management Outlook and for other tools within and outside UNEP that rely on the data. The GMFD is a unique source of EW-MFA data at the global level, recognized by the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) as part of the work of the Area C group. The objective of the Area C group is to establish a set of global SEEA databases to provide users with SEEA compliant data sets for integrated policy development and analysis, including SDGs.

GMFD metrics also continue to be used to monitor national progress against SDG targets 8.4 and 12.2, as only about 20% of countries have declared developing national EW-MFA.

Maintaining currency is also critical if the GMFD is to serve as a reference against which individual national accounts can be compared as accounts prepared by NSOs increasingly supplant the centralised version.

Another objective towards maintaining currency of the database would be advancing and standardising the processes used to screen accounts prepared by NSOs prior to possible integration. This would primarily be aimed at integrating accounts prepared in line with the EW-MFA manual UNEP (2023), but it would also be necessary to design processes for screening / integration of accounts prepared using systems such as the Eurostat Handbook.

2.2 Extending coverage to material stocks and outputs (SDG target 12.5)

The second aim, extending account coverage to material stocks and outputs, will require outflow estimates, including emissions to air, emissions to water, solid waste landfilled, and the dissipative uses of products. A major objective here is to model expected waste production by combining the material flows data with information on residence times of materials in the economy. This data will be of direct relevance to SDG target 12.5, which is monitored by UNEP's Early Warning and Assessment Division.

A secondary objective would be establishing emissions direct accounts based on aggregating the most applicable international data sets available, such as done in the GLORIA database as used in the SCP-HAT. A study conducted in parallel with the 2021 update indicated that the data available for compiling these accounts isn't comprehensive enough to supplant the modelled outputs above but will contribute vital observed data against which some of the modelled estimates can be "ground truthed".

The work shall be coordinated with UNEP's Early Warning and Assessment Division to ensure that it directly delivers into ongoing SDG monitoring processes (especially for SDG target 12.5).

2.3 Extension to circular economy-related indicators

As countries still face challenges and obstacles in their pursuit of calculating data for multiple indicators, the GMFD will be expanded with circular economy-related indicators based on the work by the UNECE Task Force on Measuring Circular Economy. The Task Force has developed Part A of its Framework on Measuring Circular Economy, adopted in 2023 by the Conference of European Statisticians. The framework has indicators on material flow accounts (material consumption and productivity trends and mix, among others). As methodologies are available for the indicators related to mineral resources, these indicators could be presented in the database by major material streams, by material category, etc.

Widely available and adopted methodologies are available to determine how this work progresses and will be used to develop information on such questions as:

- The contribution of secondary materials into the overall national economy (i.e., the circularity rate).
- Maximum achievable circularity rates under the current economic structure (i.e., the current maximum achievable circularity)
- An indication of "performance economy", denoting a measure of the quality of materials kept in stock and generating revenues and value.
- The "circularity rate", defined as how much of the managed material is kept in circulation in the economy.

The work will primarily consist in providing the data for the circular economy-related indicators outlined by the UNECE Task Force on Measuring Circular Economy. Additional indicators may be developed as needed in discussion with the working group.

It is anticipated that a major challenge here will be the sparsity of direct (observed / measured) data with sufficient resolution to determine both the quantity and detailed composition of waste and recycling flows.

One method likely to be used to compensate for this, for some major material streams, will be the limited modelling of stocks and flows (based on inputs and estimated residence times for some major materials in the economy).

Once a set of indicators has been developed, the working group will consult the IRP Steering Committee for discussion and approval before being included in the public database.

3. Policy relevant questions

[These questions flow from the objectives and will be answered by the study]

Completing the work program will maintain and extend a key piece of information infrastructure without which important questions on material use and resource efficiency cannot be objectively answered. The database will be a crucial tool to enable countries to respond to the following questions, among others:

- What is the level and rate of current global natural resource extraction and the role of different regions and countries?
- What is the difference between production and consumption side indicators such as direct material input, domestic material consumption and material footprint?
- What is the relationship between inputs and outflows of waste and emissions and how can resource management and resource efficiency best reduce issues of pollution and waste?
- What are the co-benefits of resource management for climate mitigation?
- What sectors in which economies are key drivers of resource extraction? How are resources being stocked in key sectors? Where are resources generating most value in a less resource-intensive way?
- What are the most effective mechanisms and institutional arrangements to establish satellite accounts for natural resource use and to ensure uptake by the policy community?
- What return flows of materials to the environment should we expect from end-of-life products, what fraction of this is being recorded, and what potential for increased circularity in materials use is being missed.
- What can the level of stocks across different income groups/regions tell us about the potential for implementing a circular economy in different contexts?

4. Relation with the IRP Work Programme

[Explain the study's relation with the IRP objective and strategy of the corresponding cycle as well as linkages with other work undertaken by the IRP]

The proposed scope of work for the update and extension of the Global Flows Database is a key activity under High-Impact Priority Area 1 'Current Trends and Future Prospects for Global Resource Use and Sustainable Resource Management' and feature prominently in the UNEP IRP flagship report, the Global Resources Outlook. It also provides important underpinning information to High-Impact Priority Areas 2-4 and contributes to the standing and reputation of the IRP in several global policy processes. It is also a necessary component to the delivery of several UNEP products such as for instance the SCP-HAT and the Global Footprint Tool. It is noteworthy that SCP-HAT has been used by several countries to inform their Nationally Determined Contributions (NDCs) under the

Paris Agreement. The database also allows UNEP to deliver to the SEEA data process and to support countries with crucial information for their SDG reporting needs. For these reasons the continuation of the database is a key element of the 2022-2025 Work Programme of the International Resource Panel.

5. Scope

[Specify the conceptual frameworks, approaches, methodologies, assumptions, themes, geographic coverage, and/or other issues related to the scope of the study]

5.1 Update and extension of the direct accounts of the global database:

The proposed activity will provide yearly updates for the direct accounts of the global database, covering the full set countries and regions, and at least at the same material category resolution, as covered in the 2024 GMFD. It will also extend the database by adding information for the output side.

Extension of the accounts into outputs will include emissions to air, emissions to water, solid waste landfilled, and the dissipative use and loss of products. The data will provide detail on the composition of waste flows and emissions, based on integrating the most applicable international data sets available.

To the extent that accessible international data sets support it, the waste categories reported will be in line with the SEEA recommendations for waste data, distinguishing between major waste categories such as organic waste, construction and demolition waste, plastics, electronic waste, and hazardous wastes. Emissions accounts will include the major greenhouse gas (Carbon dioxide, methane and nitrous oxide – GHG data will mainly come from the EDGAR[1]), and also available data on major, monitored air pollutants (such as nitrogen oxides, sulphur dioxide and particulate matter). These may only be provided as one, or very few aggregated categories, pending discussion with providers of the base data. Individual national waste potentials and high-level net additions to stocks accounts will also be estimated. These will be based on the material flow accounts and modelled retention times of different materials in the economy.

Initial estimates of major balancing items on both the input and output side of the accounts will also be prepared. This will be achieved mainly by researching coefficients to apply to the detailed data on major direct account items (e.g. nitrogenous fertilizers, some biomass manufactures), and assessing the suitability and limitations of accounts that can be produced via this path. If found suitable, ongoing accounts may be established later in the programme.

All material time series will extend to the year of delivery of the database, so the method of projection for late years will be a standardised process applying economically based index changes, disaggregated by economic sectors. These would be produced using CSIRO's GTEM computable general equilibrium (CGE) model.

Methodological modifications and improvements of the database will be undertaken in consultation with other initiatives such as the UN Statistics Division (UNSD) and the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA), among others. Improvements may include the assessment of non-metallic minerals and developing concordance of waste potential accounts, DPO accounts and waste statistics categories, as well as agreed allocation factors to informal economy sectors such as subsistence agriculture as performed in SCP-HAT v 2.0.

[1] Emissions Database for Global Atmospheric Research: https://edgar.jrc.ec.europa.eu/

5.2 Update and extension of the footprint accounts of the global database:

The proposed activity will also provide yearly updates for the material footprint accounts of the global database, extending from 1970 to the year of delivery. These accounts will cover at least the 173 primary countries / regions for the four material categories released in the 2024 update. Note that the number of countries covered by footprint accounts is less than for direct accounts. This is because footprinting requires that serviceable economic input–output tables exist for each country. For many small countries this is simply not the case, thus they have been aggregated into wider categories (e.g. "Rest of Asia") and assigned estimated input-output tables judged to be adequate at the group level.

The footprinting methodology will continue to use the global multi-regional input-output table GLORIA (M. Lenzen et al., 2022) methodology, which is now in its 59th iteration with forecast data until 2028. It is continuously improved as new users join the global GLORIA community, see Lenzen et al. (2022).

The project will also involve extending the footprint accounts by additional footprints in areas where the global virtual MRIO laboratory has established satellite accounts, and which are relevant to the metabolic framework of the GMFD. Here, the focus will be on waste footprints, which still require significant methodological and database development. As greenhouse gas emissions data has been updated to 2027 in other UNEP tools, the work will also conduct sanity checks for carbon footprints in the context of material balancing.

Data sources for direct material flow accounts and footprint accounts, and data assembly strategies, will be summarised in an updated technical annex.

5.3 Data integration, reporting and online dataset:

The roll-out of UNEP tutorial materials for the preparation of direct MFA accounts by NSOs means this proposal includes a component dealing with the quality assessment of individual national accounts as they increasingly come online and supporting UNEP's Early Warning and Assessment Division to establish a data repository for nationally reported MFA datasets.

This would include designing the data collation / curation protocols in collaboration with UNEP and creating the code for quality assurance / harmonisation of the NSO accounts into the basic GMFD dataset prepared from international data.

It is anticipated that UNEP would need to be the recipient and custodian of the individual NSO account data and drive the process of consultation with international statistical authorities as to what the most acceptable methods of harmonization are. The IRP's role here would be to suggest, implement, and demonstrate the results of different approaches for UNEP to then take forward in consultations and decide on which final approach to use.

In parallel to the 2021 update, individual NSO MFA accounts for a limited number of European countries, prepared using Eurostat (2018) guidelines, were compared to GMFD data. The results and an assessment of the task of integration was reported in (Lutter et al., 2021).

The IRP database was originally made available online in 2016 where it accompanied the launch of the Global Material Flows and Resource Productivity Report. To remain fully functional, alterations to hosting arrangements, and various improvements to the user interface have been necessary. Expanding the scope of data will require further changes. These will also be covered as necessary under the programme of work.

An important aspect of the GMFD historically has been reporting for the Global Resources Outlook, which includes tailored data analysis and generation of figures, tables and text. The proposed improvements as well as up to date datasets will enable IRP to continuously service this process.

6. Structure

[Lay out the proposed structure of the study]

The detailed structure of work is best understood by reading the Workplan and Timeline in section
11 below. In summary the key components are:

- Updating of the current database to include statistical records as they become available to keep the time series recent. It should be noted that as of Q4 2024, only statistical records for 2022 and 2023 have been released and can be used to replace estimated data currently in the GMFD.
- Expanding the database to include the output side of material flow accounts and to contribute to the assessment of recycling and circularity, as well as expansion to enable assessment of stocks of resources in the economy.
- Integrating methodological improvements in several areas of reporting both for the direct and footprint accounts.
- Institutional efforts to enhance the importance and uptake for the global database and to integrate with other important agencies such as the OECD and EUROSTAT.
- Developing the data for the circular economy-related indicators outlined by the UNECE Task Force on Measuring Circular Economy such as the circular material use rate and potentially others such as circularity potential.

7. Existing knowledge base and added value

[If not already included in the previous sections, briefly describe the knowledge landscape and how the study will add value.]

The global knowledge base on primary material use has expanded since 2016, responding to the policy needs of improving resource efficiency, tackling climate change and waste and pollution and enabling the net-zero circular economy. This has been reflected in the number of peer-reviewed assessments published in premier journals and in many policy reports that have referred to the use of materials as a key feature of the economic process and the main link to many environmental impacts. The public good approach of the Global Material Flows Database has especially serviced middle- and low-income countries who either have lacked the capability and/or the funding to establish their own accounts but has also triggered many national efforts at the level of science institutes and government agencies and national statistical offices. The Global Material Flows Database has put material use centre stage in the global environmental sustainability debate and continues to do so into the foreseeable future.

8. Audience, outreach, and impact

[Specify the target audiences and stakeholders, target events/policy processes to influence, outreach and dissemination plan, and the expected scale of potential impact and beneficiaries.]

The main target audiences of the global material flow and resource productivity database are:

- The international policy community and the reporting needs for SDG targets 8.4, 12.2 and 12.5.
- National statistical offices.
- Environment ministers and authorities in the context of UNEA and through the Global Resources Outlook report series.
- National policy makers who are concerned with managing environmental impacts and relating those impacts to socio-economic drivers and pressures by engaging in policy domains such as circular economy, sustainable consumption and production, resource efficiency, waste minimization and greenhouse gas abatement. This group may include, among others, Ministries of Environment, Economy, Finance, Trade, Industry, and other

authorities that can support the transition to sustainable consumption and production practices, including through industrial, economic or financial innovation.

- Private sector actors who are interested in robust information about global resource demand and supply and increasingly review their board decisions regarding the environmental implications of their investment decisions.

The use of the IRP knowledge base by government agencies is relatively well understood. The potential for engaging with the private sector needs further exploration but could well offer substantial future funding, as companies are increasingly interested in material flow data for purposes such as operational efficiency, supply chain management, sustainability reporting and regulatory compliance.

A communication strategy and path to impact analysis needs to be developed in collaboration with the IRP Secretariat to maximize the added value the global community gets from the IRP's investment into the database.

9. Proposed lead authors and contributing authors

[List the proposed lead authors and contributing authors.]

Rather than "Authors" this section refers to likely key collaborators.

The IRP currently holds core capacity for undertaking this work through its panel members and a number of partnerships.

The lead author will be Panel member Heinz Schandl.

The working group will play a key role in methodological framing and data quality assessment and will include Panel members as well as UNEP staff from different units and divisions to ensure synergies with and relevance for wider UNEP work.

The central consortium to undertake the technical work on the database would consists of:

- Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia (led by Heinz Schandl)
- Vienna University of Economic and Business, Austria (led by Stephan Lutter)
- University of Sydney, Australia (led by Manfred Lenzen)

Others who have historically made major contributions to the GMFD, and may be utilized again subject to further consultation include

- Northeastern University, Shenyang, China (led by Heming Wang)
- University of Natural Resources and Life Sciences in Vienna, Austria (led by Marina Fischer-Kowalski)
- University of Nagoya, Japan (led by Hiroki Tanikawa)

Additional partners may be sought in future work of this work stream and close collaboration will be sought with other organizations that hold experts in the domain of national material flow accounting in the EU, at the OECD and the United Nations, among others. Chief among these are UNEP's Science Partners for SCP[2], a network of scientific and technical partner institutions in all regions with the objective of creating a global partnership aimed at strengthening the science-policy interface on SCP through the uptake and mainstreamed application of the SCP-HAT and other scientific tools and resources in countries. As of Q4 2024, these partners are:

- The Energy and Resources Institute (TERI), India
- The Joint Graduate School of Energy and Environment (JGSEE), King Mongkut's University of Technology Thonburi, Thailand
- De la Salle University, Philippines

[2] https://www.oneplanetnetwork.org/science-partners-for-scp

- CLIOPE Group/Universidad Tecnologica Nacional/CONICET, Argentina
- Pontificia Universidad Católica del Perú
- Rede Empresarial Brasileira de Avaliação de Ciclo de Vida (Rede ACV), Brazil
- Research Group on Sustainability Engineering (EnGs Group), Brazil
- National Cleaner Production Centre of South Africa

10.Key resources

[List the available and required expertise. This may include database, teams, organizations, and people to consult or partner with.]

Key resources for the Global Material Flow and Resource Productivity database include novel scientific approaches provided by IRP scientists evaluated through the peer-review process.

- The implementation of new findings into the methods canon for material flow accounting.
- Ongoing subscriptions to core data sources such as UN COMTRADE, UN Energy Statistics, IEA Energy Statistics, FAO agriculture and forestry data, the USGS mining datasets and online mining databases.
- The frequent update of the GLORIA MRIO database for the purpose of footprint assessment.
- Continuation of the practice of using automated data sourcing through coding of data fees and use of digital processes and the related quality assurance protocols and tests.
- UNEP IRP facilitation of meetings between international organizations and authorities with power to agree on practice and standard in this space – e.g. reach consensus that the process(es) designed for integrating NSO accounts with the GMFD can go ahead.

Also, see organizations and people listed under Authors.

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11.Workplan and timeline

Activity and update delivery timelines overview. Timelines are indicative and will depend on contract start date.

	February 26 Update (Activity 8)	November 26 Update (Activity 9)
Direct Accounts		
Domestic extraction (activity 1)	✓	✓
Trade (activity 2)	✓	✓
GHG emissions and waste (activity 3)	✓	✓
Material balance (activity 6)		✓
Circularity indicators (activity 7)		✓
Footprint Accounts		
Material footprints (activity 4)	✓	✓
GHG emissions and waste footprints (activity 5)		✓
Project Management (activity 10)	✓	✓

Activity 1 – Update of Domestic Extraction Accounts 1

Update of the global domestic extraction (DE) dataset, based on international data sources and reporting. The DE data set will be compiled using around 60 material extraction categories, for online availability at 13 and four aggregate categories for every country, seven world regions (Africa, Asia and the Pacific, EECCA, Europe, Latin America and the Caribbean, North America, West Asia) and the world (and other aggregations as required) including updated technical documentation noting any significant changes to underlying methodology and/or datasets used. Time series to extend to 2026 (incorporating projection).

To the extent possible, the update will be coordinated through UNEP to affect all tools relying on this data, i.e. the SCP-HAT and the Global Footprint Tool.

Outputs	**Start and delivery dates**
1a. Global domestic extraction dataset updated up to 2026, using real base data until 2022-23, creating projections where necessary for latest years.	01/06/2025 - 01/10/2025
1b. Work with GTEM (CGE) modelers to obtain latest sectoral growth coefficients to apply to DE and physical trade for late year projections	01/07/2025 - 01/09/2025
1c. Provide relevant technical notes for integration into the technical annex update for the December 2025 GMFD release	15/09/2025 - 01/10/2025

Activity 2 – Update of Physical Trade Accounts 1

Update of the global trade of materials dataset, based on international data sources and reporting. As trade covers categories not relevant to DE, it will be compiled using an extended superset of that used for DE, increased from 60 to around 90 categories, then aggregated for online availability at 22 and 12 categories for all countries, seven world regions (Africa, Asia and the Pacific, EECCA, Europe, Latin America and the Caribbean, North America, West Asia) and the world, (and other aggregations as required) including updated technical documentation noting any significant changes to underlying methodology and/or datasets used. Time series to extend to 2026 (incorporating projection).

A key decision point is the extent to which we include manufactured items and final goods in the trade accounts, which are relatively small for most countries compared to primary materials. Additionally, the working group will need to decide whether to complete the concordance from HS to TCCC available in UNEP's MFA Compiler for NSOs and employ it, as this would likely lead to a significant change in the accounts, impacting DMC as well.

The crucial question is whether the IRP will want to update the entire time series or establish a historical cut-off year, such as 2019, to mark the change in methodology and explain the discontinuity. Ultimately, this change will be necessary over the longer term as NSO-assembled accounts become integrated. This point will be discussed within the IRP working group.

To the extent possible, the update will be coordinated through UNEP to affect all tools relying on this data, i.e. the SCP-HAT and the Global Footprint Tool.

Outputs	**Start and delivery dates**
2a. Physical trade accounts updated up to 2026, using real base data until 2022-23, creating projections where necessary for latest years. Develop new concordance for Comtrade data to better match that described in EW-MFA manual for use by individual NSOs	01/08/2025 - 01/11/2025
2b. Provide relevant technical notes on trade for integration into the technical annex update for the December 2025 GMFD release	15/10/2025 – 01/11/2025

Activity 3 – Extension of the material flow direct accounts to outputs

Draft extension of the accounts into outputs including initial compilations of emissions to air, emissions to water, solid waste landfilled, and the dissipative use and loss of products. The data will provide detail on the

composition of waste flows and emissions (such as organic waste, construction and demolition waste, plastics, electronic waste, and hazardous wastes), where detail can be determined based on integrating the most applicable international data sets available. Time series will be much shorter than for DE and Trade (anticipate no earlier than year 2000).

Once the draft outputs account is completed, UNEP and the implementing partner shall discuss whether it is ready for integration in SCP-HAT and the Global Footprint Tool.

Outputs	**Start and delivery dates**
3a. Source and compile data from available international data sets on emissions to air, water and land.	01/06/2025 - 01/12/2025
3b. Apply stocks and flows modeling framework to generating estimates of outputs of EOL materials for viable categories, e.g. construction minerals	01/06/2025 - 01/12/2025
3c. Combine data compiled /modelled data from 3a and 3b into draft outputs account for December 2025 GMFD update	01/12/2025 – 01/01/2026
3d. Provide relevant technical notes for integration into the technical annex update for the December 2025 GMFD release	15/12/2025 – 01/01/2026

Activity 4 – Update material footprint and raw material equivalents (RME) trade accounts

Update the national level material footprint of final demand dataset using the new DE accounts established in Activity 1, and RME import and export accounts, using the updated structure of Sydney University's GLORIA multiregional Input-Output framework current at the starting date of this activity.

To the extent possible, the update will be coordinated through UNEP to benefit all tools relying on this data, i.e. the SCP-HAT and the Global Footprint Tool.

Outputs	**Start and delivery dates**
4a. Deliver material footprint, RME imports, and RME exports accounts for integration into December 2025 GMFD release	01/08/2025 - 01/01/2026
4b. Provide relevant technical notes for integration into the technical annex update for the December 2025 GMFD release	01/01/2026 – 15/02/2026

Activity 5 – Extension of the material flow dataset (additional footprint accounts)

Include national level GHG footprint of final demand dataset and develop waste footprint of final demand dataset using the new GHG emissions and waste accounts established in Activity 3 using the updated structure of Sydney University's GLORIA multiregional Input-Output framework current at the starting date of this activity. For greenhouse gas emissions, the bulk of the work will consist in conducting sanity checks (see section 5.2 above).

To the extent possible, the update will be coordinated through UNEP to benefit all tools relying on this data, i.e. the SCP-HAT and the Global Footprint Tool.

Outputs	**Start and delivery dates**
5a. Deliver GHG and waste accounts for integration into December 2025 GMFD release	01/11/2025 - 01/01/2026
5b. Provide relevant technical notes for integration into the technical annex update for the December 2025 GMFD release	01/01/2026 – 15/01/2026

Activity 6 – Initial balancing items accounts

Draft extension of the accounts to include a selection of the most significant and tractable balancing items, notably major inputs of atmospheric gases and bulk water to products tracked by FAO, cement and fertilizer production if available.

Outputs	Start and delivery dates
6a. Compile data from available international data sets on materials which can reasonably have major balancing items modelled from them and construct initial balancing items account from that.	01/06/2025 - 01/12/2025
6b. Provide relevant technical notes for integration into the technical annex update for the March 2025 GMFD release	15/12/2025 – 01/01/2026

Activity 7 – Expansion to Circularity Indicators

Develop the data for a set of circular economy indicators based on the framework 'Measuring Circular Economy' developed by the UNECE Task Force on Measuring Circular Economy and other widely available and adopted methodologies to the extent that material flow accounts provide the necessary data. The IRP will assess the methodologies and will coordinate with UNEP to ensure synergies with existing work. Once a set of indicators has been developed, the working group will consult the IRP Steering Committee for discussion and approval before being included in the public database. These indicators will measure the contribution of secondary materials into the overall national economy (i.e., the circularity rate). We will also provide informed estimates related to the maximum achievable circularity under the current economic structure (i.e., the current maximum achievable circularity) and the circularity gap, which is defined as how much more is there to gain in terms of circularity.

Outputs	Start and delivery dates
7a. Selection of indicators to be included in the GMFD in consultation with the IRP Steering Committee	01/12/2026 - 01/02/2026
7b. Compiled dataset for circular economy indicators for integration into August 2026 GMFD release	16/02/2025 - 15/07/2026

Activity 8 – Assembly and upload of December 2025 version of GMFD

Assemble direct accounts and RME based accounts created in earlier activities, calculated the key aggregates (regional / global) and ratios (per capita /GDP) traditionally in the database, incorporate any of the new extensions subject to review and agreement with UNEP, and bring into commission as the latest update of the GMFD.

Outputs	Start and delivery dates
8a. Create regional and global aggregates for direct and RME accounts, produce ratio indicators, and integrate into database for upload to become new online database	01/01/2026 - 15/02/2026
8b. Integrate technical notes on updates and changes gathered in earlier activities into updated technical annex update for the December 2025 GMFD release	01/01/2026 - 15/02/2026
8c. Put initial updated GMFD online. Extend final year of time series to 2026, including new projected data.	01/01/2026 - 15/02/2026

Activity 9 – Ongoing review and integration of new data for delivery of second update in August 2026

Use the period after the December 2025 update to implement integration of those experimental datasets (outputs, balancing items, additional footprints) judged ready for integration with the main GMFD, in consultation with the IRP. Also incorporate any major updates in base data which become available before April 2026 into second update release of GMFD in August 2026, with time series coverage extended to 2028.

Outputs	Start and delivery dates
9a. Review and refine the new, additional indicators selected (for outputs, balancing items) in close consultation with IRP, for inclusion into the GMFD, release version August 2026.	16/02/2025 - 15/09/2026

9b. Redo any steps for Activities 1 to 4 above required to integrate data from the base data sets which have been updated since the December 2025 GMFD release	16/02/2025 - 15/09/2026

9c. Integrate technical notes on the new indicators into an updated technical annex for the August 2026 GMFD release	01/09/2026 – 30/10/2026
9d. Repeat steps from Activity 8 required to put updated and expanded GMFD online, with last year of time series 2028	01/09/2026 – 30/10/2026

Activity 10 – Extension of socio-economic indicators

Inclusion of the Human Development Index (HDI) for every country and territory where the indicator is provided for by the UN Development Programme (UNDP). This will be included in the February 2026 data release and updated in the October 2026 release.

Activity 11 – Project Management

This covers all activities related to coordinating all collaborators on the project towards delivery, including contracting matters, organizing and recording project / team meetings where appropriate, and meeting all interim and final reporting requirements.

Outputs	**Start and delivery dates**
11a. All activities related to directly coordinating project teams towards delivery, organizing and recording / reporting project team meetings where appropriate, and meeting all interim and final reporting requirements.	01/06/2025 - 30/11/2026

12.Budget

[Include a detailed breakdown of the cost, including research, travel, meetings, publishing, etc., as applicable.]

Budget					
Activity	**Expected by (month/year)**	**Unit**	**Quantity**	**Unit cost (USD)**	**Total cost (USD)**
Activity 1 – *Update of Domestic Extraction Accounts 1*					
Research, data engineering, and technical support	*Jun-25*	*Daily rate for coder / researcher*	44	750	33,000
Data Acquisition	*Jun-25*	*Base data subscriptions (IEA and/or UNSD Energy)*			2,000
Activity 2 – *Update of Physical Trade Accounts 1*					
Research, data engineering, and technical support	*Aug-25*	*Daily rate for coder / researcher*	34	750	25,500
Data Acquisition	*Aug-25*	*Base data subscriptions (Comtrade)*			2,000
Activity 3 – *Extension of the material flow direct accounts to outputs*					
Research, Data Engineering, and technical support	*Jun-25*	*Daily rate for senior researcher*	62	750	46,500
Activity 4 – *Update material footprint and raw material equivalents (RME) trade accounts*					
Research, data engineering, and technical support	*Aug-25*	*Daily rate for coder / researcher*	10	750	7,500
Activity 5 – *Extension of the material flow dataset (additional footprint accounts)*					
Research, data engineering, and technical support	*Nov-25*	*Daily rate for senior researcher*	26	750	19,500
Activity 6 – *Initial balancing items accounts*					
Research, data engineering, and technical support	*Jun-25*	*Daily rate for senior researcher*	31	750	23,250

Activity 7 – *Develop Initial Circularity Indicators*					
Research, data engineering, and technical support	*Dec-25*	*Daily rate for senior researcher*	24	750	18,000
Activity 8 – *Assembly and upload of March 2025 version of GMFD*					
Data engineering, and technical website support	*Jan-26*	*Daily rate for coder / researcher*	25	750	18,750
Activity 9 – *Ongoing review and integration of new data for delivery of second update in December 2025*					
Data engineering, integration and technical support 2nd update of DE, Physical Trade, Material Footprint	*Feb-26*	*Daily rate for coder / researcher*	58	750	43,500
Data Acquisition for direct accounts 2nd update	*Feb-26*	*Renew base data subscriptions (IEA and/or UNSD Energy and Comtrade)*			4000
Data engineering, integration, and technical support for Integration of New Account Items with GMFD	*Feb-26*	*Daily rate for coder / researcher*	31	750	23,250
Data engineering, and technical website support	*Feb-26*	*Daily rate for coder / researcher*	9	750	6,750
Activity 10 – Extension of socio-economic indicators					
Data compilation, concordance, and integration into GMFD	*Jun-25*	*Daily rate for coder / researcher*	3	750	2,250
Activity 11 – *Project Management*					
Coordination and administration of collaboration needed to deliver GMFD, and associated reporting requirements.	*Jun-25*	*Daily rate for research (Dr Jim West)*	31	750	23,250
Total Cost (USD)					**299,000**

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Name reviewer/Country	Chapter No	Type of comment General (G) / Specific (S)	Page	Line	Comment	Working Group Response
Philip Nuss/Germany	-	G	–	–	Thank you for the detailed project description which provides a clear and well-structured overview of the envisaged update and expansion of the Global Material Flow Database (GMFD). We agree that this work stream is a crucial product of the IRP and provides the basis for flagship reports such as the GRO and other UNEP products such as the SCP-HAT. It therefore needs to be continued and further	
European Union		G			In general, we value the extension to circular economy-related	
European Union		G			We are glad to contribute to the Task Force on Measuring Circular Economy.	Secretariat: Certainly. This was agreed at 32IRP, see Conclusions, Session 19: "Consult Steering Committee on the selection of circularity indicators for policy relevance". We would add the Panel to the consultation as well. A selection of indicators will be presented to the Panel and Steering Committee for discussion prior to including new circularity indicators in the
European Union		S	4	68	A trustworthy publicly available database with comparable data on worldwide scale has a great benefit. The argumentation of the importance "for IRP to recapture this space" in line 68 f. is not needed to justify these efforts.	Heinz: Noted. However, we wanted to highlight the business model of Circle Economy, which commercializes publicly available methods and data—such as those from the IRP database—to sell its Circularity Gap Report to countries at a significant cost. We believe it is important to support countries, particularly in the Global South, in accessing information from the IRP's publicly available database. Additionally, we have fallen behind in capturing waste management and resource recovery aspects of material flows, as well as the rapidly growing significance of circularity metrics. In some ways, the IRP process is not agile enough to keep
European Union		S	4	87	In addition, the link and the data need for the UNEP Global waste management outlook in line 87 could be added.	Heinz: We will include this in the TOR, as there is a significant opportunity for collaboration between the IRP and the UNEP Waste Initiative, particularly in relation to the Global Waste Management Outlook.
Japan	2.3	S	Page 5	120	Regarding the proposed extension of GMFD to include CE related indicators, the selection of UNECE indicators are not static and expected to evolve over time to meet emerging policy demands. We strongly suggest that opportunities will be provided for both Panel and SC to discuss the selection of additional indicators to be included in the database, rather than simply adopting the	Secretariat: Certainly. This was agreed at 32IRP, see Conclusions, Session 19: "Consult Steering Committee on the selection of circularity indicators for policy relevance". We would add the Panel to the consultation as well. A selection of indicators will be presented to the Panel and Steering Committee for discussion prior to including new circularity indicators in the database.
Philip Nuss/Germany	11	S	13	458	Synergies with other UNEP products: You mention that the GMFD is also required for the SCP HAT, the Global Footprint Tool and the SEEA data initiative. Is there separate funding from these sources and how does this complement the IRP-related funding contributions (it would be good to highlight these interconnections in the ToR)? Furthermore, IRP/32/14 (outcome from UNEP-IRP meeting June 2024) highlights that the GMFD's institutional foundation will be strengthened with an allocation of USD 250k. This is very much welcomed, but the connection in terms of overall funding and future institutional sustainability with this ToR is still unclear.	Secretariat: (1) SCP HAT and Global Footprint tool are funded on the basis of available funding opportunities through donor calls for proposals. The respective teams have already and will continue presenting joint proposals when opportunities arise. (2) The MFA work encompasses activities ranging from the "core" (technical work on the GMFD, reflected in these ToRs) to developing national capacities - the latter is critical as enhanced national capacities to develop national MFA accounts will lead to more MFA data availability in the long term, which will in turn improve the quality of the GMFD. UNEP teams from Paris and Nairobi cooperate as requested by the Steering Committee. Therefore, UNEP has provided $250k from the Environment Fund to be used as follows: $100k managed by IRP Secretariat to support working group meetings, capacity building and IRP Secretariat staff, $150k managed by the SDGs & Environment Statistics Unit (UNEP Early Warning & Assessment Division, formerly Science Division) to develop MFA e-training modules as part of UNEP's work to build capacities on MFA in countries. These ToRs only focus on the "core", i.e. the technical work on the GMFD, which is carried out
Philip Nuss/Germany	6	S	9	292	Indicator selection: The selection of CE indicators shall be based on the UNECE Guidelines for Measuring Circular Economy and a decision within the MFA working group. We believe that the IRP steering group (SG) could help to further ensure policy relevance of the final indicator choices and encourage the IRP experts to consult	Secretariat: Certainly. As above, this was agreed at 32IRP, see Conclusions, Session 19: "Consult Steering Committee on the selection of circularity indicators for policy relevance". We would add the Panel to the consultation as well. A selection of indicators will be presented to the Panel and Steering Committee for discussion prior to including new circularity indicators in the database.
Philip Nuss/Germany	5	S	7	195 and following	Data: You mention that GHG and waste footprints will be incorporated in the GMFD. Given that the GRO and SCP HAT also cover biodiversity loss and air pollution, would it be possible to also include those environmental extensions (to cover the UNEP "triple planetary crisis")?	Heinz: The Global Material Flow Database employs the industrial metabolism framework and focuses on pressure indicators, including materials, waste, and emissions. While the environmental impacts of climate change, biodiversity loss, pollution, and resource depletion are intrinsically linked to metabolic patterns, they are currently outside the remit of the global database. However, there is an opportunity for the IRP to make environmental impact data available and potentially link it to the GMFD. Additionally, please note that SCP-HAT also reports environmental impacts in a publicly accessible form, though the
Philip Nuss/Germany	-	G	-	-	Data: Given that environmental footprints will be covered using GLORIA, will chapter 3 of the GRO 2028 also be based on this data (use synergies here!)?	Heinz: This needs to be discussed within the GRO team once it has been established. However, efforts were already made in GRO24 to harmonize the tools used for the report.
Philip Nuss/Germany	-	G	-	-	The GRO 2024 also included a CE Sankey visualization based on the GMFD. Would it be possible to provide visuals like this for countries in the GMFD? This would make the IRP "competitive" also with other commercial providers of such data such as the Circularly	Heinz: Improved visualization and the availability of Sankey diagrams for all countries will be a major output of the revised database. This is exactly what is needed to enhance the IRP's competitiveness in the circular economy metrics domain. See also my previous response on recapturing this space.
Philip Nuss/Germany	1	S	3	37	Finally, it would be good to foster discussions with EU countries on how to further integrate their national accounts into the GMFD and on differences in footprint estimates (material footprint, carbon footprints etc.). How this will be done was still a bit unclear to us?	Heinz: This is indeed very important but also goes beyond the remit of this project. To my understanding, the responsibility for collecting reported national data lies with the UNEP Office in Nairobi. Their assessment is that, for now, nationally reported data and the IRP database should remain separate, as they serve different functions and have very different coverage. Over time, they will likely merge into a single resource, but this process may take up to a decade to be finalized. Nevertheless, this step toward harmonization is very much on the radar of the metrics working group.

32IRP Meeting Comments (Panel, Joint, Steering Committee Meetings)						
Stefan Bringezu		G			Include 'unused' portion of resources extracted with aim to monitor not only used extraction, but also total extraction. Here are characterization factors for RMI and TMR can be found (in order to include both used and unused extraction into the IRP database): https://daks.uni-kassel.de/bitstreams/750aa8fb-f795-465e-99c1-	Heinz: We will further explore this request to determine the best way to address it.
Helga Weisz / Netherlands		G			Is it possible to include disaggregated categories of major uses of materials (e.g. biomass for food, biomass for combustion…)? This could help link to the work on Science-Based Targets.	The way the waset potential is calculated employing a stock and flow approachrequires a distinction of main use categories of input materials and we can discuss to which extend this information can be provided perhaps not as a main reporting feature but upon request.
Hans Bruyninckx		G			Consider issues resulting from levels of aggregation of circularity indicators. There is a need for expansion in the direction of precision data on elements that are not so easily capctured by broad data gathering schemes that often focus on large quantities	Heinz: The calculation of waste potential using a stock and flow approach requires distinguishing the main use categories of input materials. We can discuss to what extent this information can be provided, perhaps not as a primary reporting feature, but upon request.
Belgium		G			Waste data: is it possible to estimate informal activities related to	Heinz: This is not currently planned, as there is a need for coherent definitions and a lack of sufficient data.
Japan		G			Can you look into indicators of renewable resources, regenerative resources? Either micro or more macro indicators? I.e. renewable materials, regenerative materials.	Heinz: This request requires further specification, after which we can assess whether it can be addressed.
Canada		G			Please distinguish more clearly between different waste categories.	Heinz: High-quality and disaggregated waste data is often unavailable, which is why we need to model waste flows for countries where such data is lacking. The extent to which we can provide detailed information will need to be further
Canada					Please display more disaggregated material categories	Heinz: Disaggregated material flow data has been available upon request, and there is a need to strike a balance between detail and accessibility on the online platform.

UN environment programme

International Resource Panel

PROPOSAL FOR THE DEVELOPMENT OF AN IRP SCIENCE-BASED TARGET STRATEGY

TERMS OF REFERENCE for a Rapid Study and Assessment

Prepared by Michael Obersteiner, Stephanie Hellweg and Helga Weisz
with inputs from Stefan Bringezu, Paul Ekins, Paul Lucas, Keisuke Nansai

1. BACKGROUND

The International Resource Panel (IRP) has decided to investigate options to support the formulation of science-based targets (SBT) that are connected to IRPs mandate. “Science-based targets” has become a vibrant action-oriented activity at the boundary between policy making, action setting and scientific assessment.

It is the purpose of these terms of reference to assess and sketch out a possible strategy for the IPR to:

- position the IRPs role in the wider science-based target setting processes
- plan for a science-based target workstream that is coordinated with other ongoing and planned IRP workstreams as well as the wider science-based target community

Here we will first map the SBT landscape, discuss potential principles for target setting, sketch out target setting under the Sustainable Development Goals (SDGs) and finally conclude with a set of recommendations on where and how the IRP could best contribute.

The SBT process builds on the success and experience in climate target setting. The IPCC with its assessments has played a significant role in helping inform the process of target formulation for a single convention - the UNFCCC.

Building on this legacy the Earth Commission – a newly established scientific assessment body under Future Earth - is designed to be complementary to and build on the work of already established scientific assessment bodies such as the IPCC, IPBES and GEO (UNEP Global Environmental Outlook). The Earth Commission was established to inform processes concerned with science-based target setting through these intergovernmental bodies. The Earth Commission is a group of leading scientists and experts convened by Future Earth with the task of synthesizing the latest science to underpin the development of science-based targets for “systems like land, water, and biodiversity”. The Earth Commission will analyze the latest science to publish reports defining the conditions for a stable planet. 20+ Commissioners were appointed in September 2019 and the work of the Commission has commenced. The IRP will have an observer status and Stefan Bringezu has become a Commissioner and been entrusted with an additional function of linking to the Science-Based Targets Network (SBTN). Future Earth will host the Earth Commission’s scientific secretariat in collaboration with Potsdam Institute for Climate Impact Research (PIK), and the International Institute for Applied Systems Analysis (IIASA). The latter two institutes also have representation in the IRP.

There are two science-based processes - The Science-Based Pathways Initiative (SBPI) and the Science-based Targets Network (SBTN) – which will be informed by the assessments of the Earth Commission (see Figure 1). Other indicator and potential target setting processes such as related activities conducted by the European Environment Agency, the Japanese Sound Material-Cycle Society and the Chinese policy for a Circular Economy will also be considered.

The SBPI will build on the extensive network of global research projects and knowledge action networks to generate new research at national, regional and global levels. The multi-level approach of the SBPI is focused on a bottom-up assessment starting from the national level. The national processes will use structured back-casting methodologies to develop integrated pathways to meet the four life-supporting target areas of the SDGs:

1. biodiversity (SDG 15)
2. oceans (SDG 14)
3. land (SDG 15)
4. freshwater (SDG 6)

These four research and policy domains are also part of the IRPs research domains, where freshwater and land seem to be the least represented by past and ongoing IRP work – in particular, the Global Resources Outlook (GRO) report. Past IRPs GRO scenarios have not been vetted by a more bottom-up consultation with national input or inputs from international stakeholder groups. However, with respect to Biodiversity and Climate there are early signs that Parties to the UNFCCC and UNCBD are coordinating across their National Determined Contributions (NDCs) and National Biodiversity Strategies and Action Plans (NBSAPs) in respective pledging and ratcheting up processes. The Climate conference in Glasgow in 2021 and the CBD Conference of the Parties (COP) in Kunming in 2021 will demonstrate progress of coordinated ratcheting up of their ambitions. However, ratcheting up will unlikely lead to revisions of established targets or the ongoing target setting process.

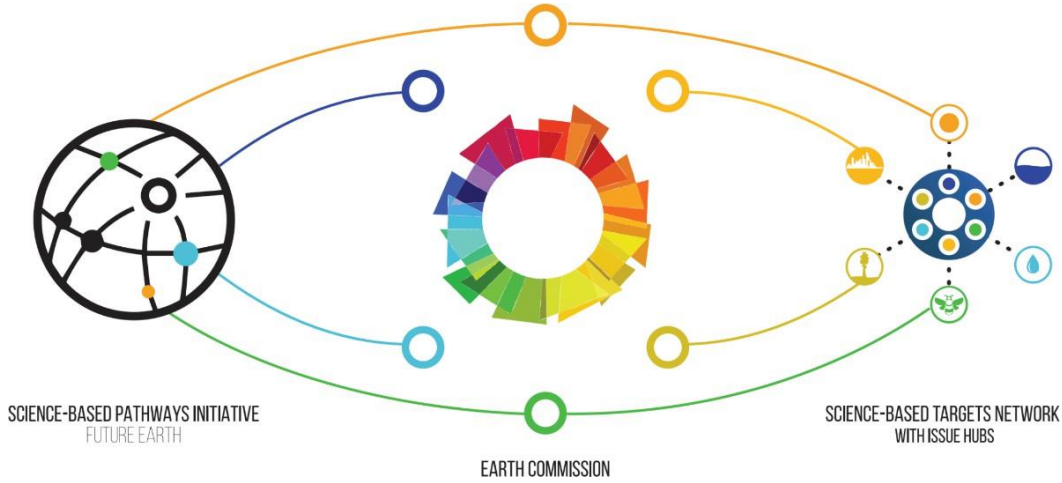


Figure 1: *The Earth Commission is set up to inform two parallel processes. The work of the Science-based pathways initiative (SBPI) will provide cross-scale assessments by the science community supported by Future Earth. Private sector and city level action-oriented work will be "informed" by the Earth commission, but be managed by the Science-Based Targets Network (SBTN) – more commonly known today as the Science-Based Targets Initiative (SBTI)*

All four dimensions are part of the IRPs scenario work and thus these resources can readily be used for science-based target setting work under the IRP. Related global pathways scenario exercises along the above-mentioned resources were also recently subject to vetting by the business sector entities involved in the SBTN(I) i.e. WBCSD. Some of this work was carried out under the leadership of the Food and Land Use Coalition (FOLU) in their Growing Better report. Related national pathways were recently published by the Food, Agriculture, Biodiversity, Land-Use, and Energy (FABLE) consortium. It has already built coordinated pathways along the dimensions of Food, Agriculture, Biodiversity, Land and Energy, essentially anticipating the planned work (which has not started yet) of the SBPI. The FABLE consortium as well as the FOLU scenario exercise have formulated their own quantitative sustainability targets with respect to the above-mentioned resources. It is not clear what the value-add will be of the pathways under the SBPI.

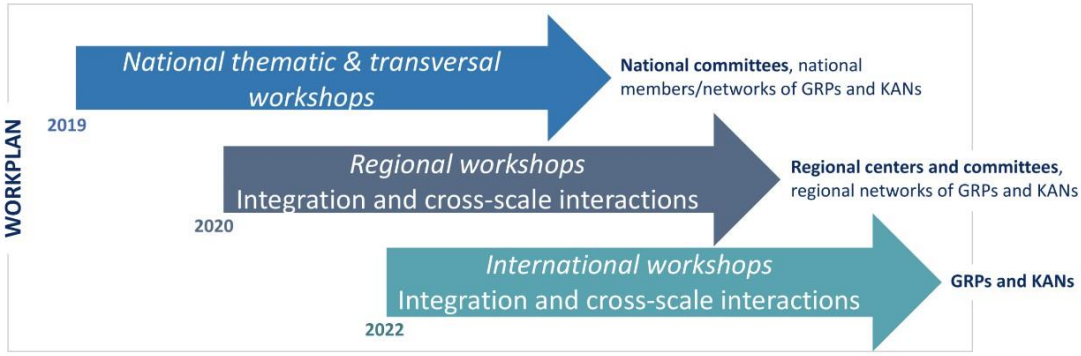


Image: Workplan for the Science-Based Pathways for Sustainability Initiative (Future Earth), with on the right envisioned roles for each entity of the Future Earth community: Global Research Projects (GRPs), Knowledge-Action Networks (KANs), National committees and Regional Centers and Committees.

Figure 2: *SBPI will carry out a series of national processes, followed by consolidation and integration at the regional and global level*

As opposed to the global work of the IRP, the outputs of the SBPI (see Figure 2) are targeted at country level assessments producing: (i) policy briefs and publications that describe the identified pathways and the political and societal decisions that will need to be taken to implement them; (ii) discussion papers on national and regional research priorities that identify priority transdisciplinary research needs to support knowledge-based decision making; and (iii) establishment of formal or informal networks of stakeholders and strengthened links to existing national and regional stakeholder platforms that are working on sustainability issues. It is unclear how the national work of the SBPI will be coordinated with the respective national and international policy and scientific assessment processes in the four life-supporting SDG domains.

Box 1 Conclusio

SBPI

- The target scope with focus on biodiversity, ocean, land and freshwater overlaps with the IRP scope. Abiotic resources do not seem to be in the SBPI's focus
- IRP has observer status in the Earth Commission and might thus enable coordination of IRP scenarios with scenarios and assessments under the Earth Commission.
- The SBPIs timeline is similar to the IRPs GRO timeline. The authors of this report have no knowledge on whether the work of the SBPI has already started and whether the work is on track.

SBTN (SBTI)

- The SBTN has recruited 800+ global companies and cities who set Zero Net GHG emission targets
- The scientific underpinning of target setting is still to be improved and the set of target dimensions is bound to be expanded
- The SBTN is fully operational and has embarked on processes to improve its methodologies (e.g. GHG accounting for NBS)
- The set-up of the IRP is not in sync with the fast delivery processes of the private sector. However, knowledge products of the IRP could be designed to support company and city level activities. Mechanisms to support company/city level target setting are yet to be worked out.

The SBTN was set up to develop methodologies for companies and cities informing specific science-based targets to guide actionable strategies. The Science-Based Target Initiative[1] (SBTI) (seems to be the new brand) has become an operational network of some 800+ global companies who have set company specific targets. Target setting is currently focused on climate targets i.e. Zero Net GHG emission balance targets for 2030/50. The SBTI has developed specific methodology, established case studies and is supported by a technical advisory group to help companies in setting and eventually managing targets. There are efforts under way to broaden the scope to other resource domains such as biodiversity, water and land. The SBTIs main partner organizations are CDP, UN Compact, WRI and WWF in collaboration with We Mean Business. Most of the Scope 3 accounting work of the SBTI is based on Life Cycle Assessment (LCA) methodology with private sector service companies (e.g. Quantis) providing technical support. Many participating companies have established ambitious targets and are currently building capacity for strategic planning and operational implementation. SDG12 related activities (i.e. resource efficiency) appear as a major component of the overall framing of company level strategies. Some companies have also formulated circularity measures to reach their specific targets. Likewise, cities have formulated Science-based Zero Net GHG targets. The target setting methodology is straight forward and relies on down-scaling IPCC overshoot 2-degree scenario pathways to sector/company/city levels.

PURPOSE

The purpose is to produce a Rapid Study and Assessment which makes recommendations for an improved positioning of the IRP in the wider science-based target setting processes taking its resources lens. Furthermore, it is the purpose of the scoping note to coordinate with other ongoing and planned IRP workstreams as well as the wider science-based target community on issues of SBTs. Finally, this Rapid Study and Assessment will provide input to the quantitative scenario assessment workstream of the conjectured targets of the IRP.

The scenario workstream, which in turn delivers into the new GRO23, will strongly depend on guidance on how to formulate forward looking scenarios which are in line with a common IRP narrative on SBT. The final goal is that numerical values will be elaborated for resource targets, which will enter the scenario models either as desirable resource use constraints or even enter parts of the objective function of the models.

RATIONALE FOR THIS REPORT

IRP specific contributions to support the setting of science-based targets will need to adhere to the objectives and principles set by existing science and policy processes. Many policy processes, which are also falling into the IRPs competences, have already formulated specific objective statements and have progressed and embarked on a target formulation process subject to continuous evolution of refinement and reformulation. See Box 2 for UNFCCC process. The proposed work on target formulation will also be coordinated with work related to UNEA resolution on "Innovative pathways to achieve sustainable consumption and production" and the work of the Task Group on catalysing science-based-policy action on SCP.

While target setting under the UNFCCC has focused on a single overall global climate mitigation target, other conventions and policy processes have embarked on a different strategy of setting a multitude of targets such as the Aichi targets under the UNCBD. The CBD targets are currently being revised and might also become streamlined into a much smaller set of targets, and potentially even a single overarching apex target formulation. A zero draft paper is currently in circulation for consultation under the CBD negotiation.

[1] https://sciencebasedtargets.org/

Box 2: The UNFCCC's objective is formulated in terms of "*stabilization of greenhouse gas concentrations… that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to*

- *allow ecosystems to adapt naturally to climate change*
- *ensure that food production is not threatened*
- *enable economic development to proceed in a sustainable manner*"

The UNFCCC process started early on from a GHG stabilization target formulation of 450ppmV CO2eq in the atmosphere. At that time Integrated Assessment Models provided climate mitigation scenarios not below 450 ppmV. This target formulation evolved into a temperature target formulation of 2C and later 1.5C. Science contributed very little to this shift in formulation.

Integrated Assessment Models nowadays foresee a maximum attainable climate mitigation target in line with the one set by the Paris Climate Agreement. The three criteria of choosing the right GHG concentration (temperature) target in terms of ecosystem adaptability, food and economic sustainability never entered the political discourse of target setting. This is in part due to the lack of scientific evidence to support these criteria or reluctance of considering scientifically established facts on them. Thus, it is debatable whether the target setting process under the UNFCCC can actually pass the criteria of "science-based".

The SDGs were also formulated under a specific set of objectives and principles. The IRPs target setting process will most likely adhere to these objectives and principles. There are many templates available for principle setting such as the SMART concept.

There are a number of established principles and criteria frameworks for target setting which the IRP could readily adopt. There are also methodologies to formulate composite indicators to track progress of multiple sustainability domains such as the Strong Environmental Sustainability Index (SESI)[2] or the SDG index[3] In addition, the IRP might want to consider some of its own complementary objective and principles for target formulations. For example, in relation to the IRP's goal to act as an integrator of many SDGs (going beyond the Earth Commissions focus and adding a social and economic dimension) and due to its Theory of Change alignment with the DPSIR framework the IRP might want to embark on a hierarchy of targets starting from impact all the way to metabolic targets. The latter might even be postulated and formulated if impact targets are difficult to quantify or even not measurable.

Conclusion

- The IRP does not have a parent Convention, however, an objective formulation of the IRP's domain of work would be conducive to SBT development.
- The IRP needs to establish and agree on the principles and criteria guiding its target setting process. The scoping paper will provide that guidance.
- The IRP might want to consider establishing a coordination body for target setting with other international processes - Earth Commission might not be enough.
- The IRP might want to propose one or a few quantitative science-based target
- The IRP will need to decide and agree on a number of target formulations for the next round of IRP integrated scenarios workstream
- The IRP might consider adopting target formulations from other target setting processes or define a few in its own right.

[2] https://sustainability.sciencesconf.org/data/pages/E1_Liano_Ekins_1.pdf
[3] Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G. (2019): Sustainable Development Report 2019. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

There are two issues and questions to be tackled by the scoping study:

1) **Impact targets**: Which SDG indicators could in principle qualify as impact target measures to be potentially assessed as “exogenous driver targets” by the IRP?;
2) **Connecting impact targets to resource use targets**: What are the IRP inhouse indicators which we monitor and could be core to the IRP integrated scenario model suit?;
3) **Defining the principles to define such impact and resource targets**;
4) **Explaining and prioritizing those resource flows and targets that a most co-beneficial for several agendas**

The SDGs provide a useful and practical set of indicators which could support the formulation of a target setting processes within the IRP. At a minimum they could serve as a useful starting point. It is also important to note that the SDG indicators are more likely to be consistently monitored across countries under the guidance of UNSTAT. Actual measurability is an important criterion for selecting a target indicator (there is no use formulating a target for an indicator where there is no measurement planned by UNSTAT or any other trustworthy observation system).

What we see from Table 1 is that there are very few SDG indicators which would qualify for a unique IRP impact indicator relating to state of resources. Most states of resources are under the regulation of specific (environmental) conventions. A unique IRP contribution could be a target setting of material utilization to reach multiple goals relating to multiple resource types regulated under separate conventions. A quantitative material utilization target formulation would require scientific evidence from specifically targeted modelling studies by the IRP.

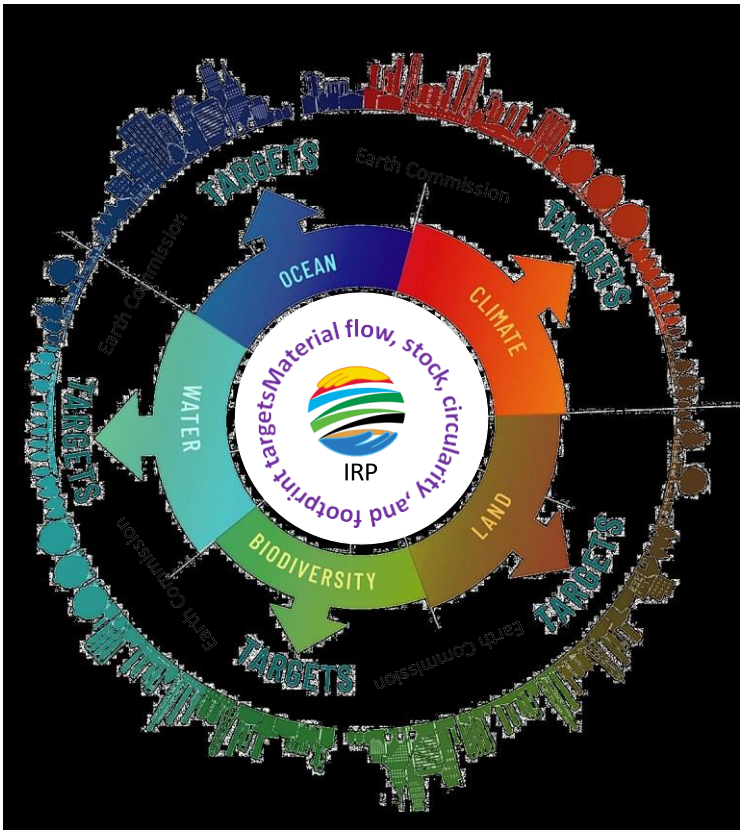


Table 1: *Preliminary mapping of SDG indicators by resource domain. SDG indicators potentially qualifying as environmental impact target formulations are identified together with potential target quantification. Last column identifies SDG indicators which would allow for the tracking of progress of intervention measures supporting progress towards target fulfilment. *indicate compatibility with quantitative IRP assessments*

Resource Domain	SDG Indicators relating to environmental impact/state	Target formulation based on indicator	Intervention targets *Covered by IRP Assessment **Planned to be covered by IRP Assessment
Land	15.5.1 Red List Index	x% improvement of rarity and abundance	15.1.1 Forest area as a proportion of total land area*
			15.1.2 Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type**
			15.2.1 Progress towards sustainable forest management*
	15.3.1 Proportion of land that is degraded over total land area	Zero Net Degradation	12.3.1 Global food loss index and SDG1,2,3 relating to Healthy Diets and Healthy People*
	15.4.2 Mountain Green Cover Index	tbd	15.4.1 Coverage by protected areas of important sites for mountain biodiversity
Freshwater	6.3.2 Proportion of bodies of water with good ambient water quality	Critical loads of pollutants and water quality state variables	6.3.1 Proportion of wastewater safely treated**
			6.4.1 Change in water-use efficiency over time*
			6.6.1 Change in the extent of water-related ecosystems over time**
	6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	Environmental Flow criteria*	
Ocean	14.1.1 Index of coastal eutrophication and floating plastic debris density	tbd	Constraints on N, P inflow**
	14.3.1 Average marine acidity (pH) measured at agreed suite of representative sampling stations	tbd	Part of new set of IRP climate scenarios**
	14.4.1 Proportion of fish stocks within biologically sustainable levels	X%	14.5.1 Coverage of protected areas in relation to marine areas**
Air	11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (popn weighted)	Critical loads	Part of the IAM climate scenarios **
Climate	SDG 13: Global Temperature	Paris Agreement	SDG 7 and 15 Targets
Minerals, Metals and Fossil	Not existing	tbd	12.2.1 Material footprint, material footprint per capita, and material footprint per GDP*
			12.2.2 Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP*
			12.5.1 National recycling rate, tons of material recycled (?)
			12.4.2 Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment (?)
			7.2.1 Renewable energy share in the total final energy consumption*
			7.3.1 Energy intensity measured in terms of primary energy and GDP*

Table 1 does not include Human Health and Welfare impact indicators which naturally will have an impact on the use of natural resources. For example, SDG indicator “3.9.1 Mortality rate attributed to household and ambient air pollution” can be related to critical human health load definitions of air pollutants. Debatably, for the purposes of the IRP, human health and welfare indicators can be treated as auxiliary intervention targets to achieve broader environmental health. For example, the implementation of policies aimed at compliance with critical loads for exposure of pollutants to humans could also lead to compliance with ecotoxicological definitions for air, water, soil or ecosystem and vice-versa. Likewise, SDG target indicator “3.4.1 Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease” could be used for the formulation of a human health impact target indicator which would drive directly or indirectly resource use where, for example, healthy diet prescriptions would reduce excessive food consumption leading to obesity and at the same time reduce pressure on land-expansion through reduced food consumption.

Table 1 contains many “intervention targets” which relate to state of resources (e.g. forest area fraction) or to metabolic rates (e.g. changes in water use efficiency). These targets cannot be regarded as “impact targets” and rarely measure ecosystem health or impact on human health. In addition, target formulations under the SDGs do not relate to the functions resources and ecosystems provide (e.g. the source – sink function). There are also no references made to the rarity or abundance of resources.

The IRP inhouse indicators which we monitor and could project while Table 1 maps indicators mostly in-line with GRO Chapter 4 assessment. Figure A.3 shows GRO Chapter 3 indicators along the impact chain of environmental intervention, impact categories and damage categories. Many of these LCA indicators are used to formulate critical load targets reflecting environmental regulation of categories such air, soil, water and food quality connecting to human and ecosystem health/toxicity. In this area of target setting there seems to be little room for the IRP to support setting of new targets. Frontier areas are for example biodiversity impact indicators and targets. In these frontier areas there does not seem to be a large space for the IRP to help formulate new

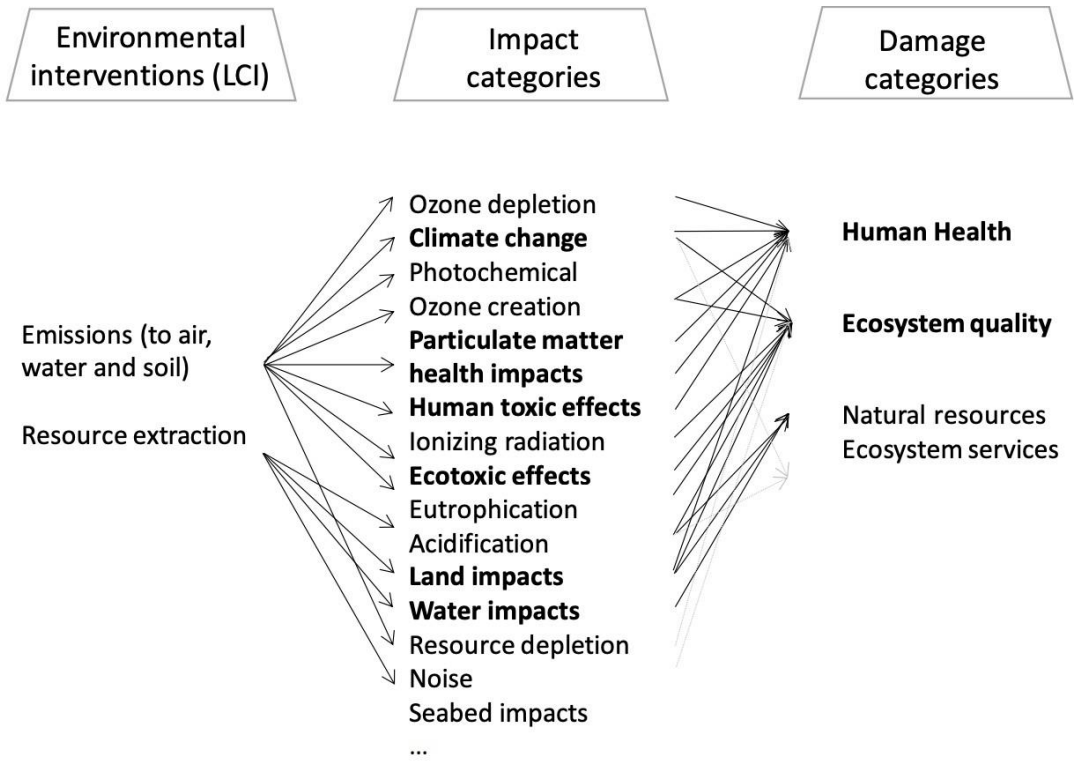


Figure A.3: Excerpt of framework of Life Cycle Impact Assessment. All impact categories quantified in this report are printed in bold. (figure adapted from UNEP-SETAC 2016) (UNEP SETAC 2016)

targets. However, the implementation of a multitude of damage and impact categories targets in IRP assessments poses an interesting challenge with large opportunity to motivate resource efficiency and circularity. Almost surely, a ubiquitous implementation of human and ecosystem health targets would necessarily promote improved environmental performance. For example, the latest policies in Switzerland and EU member states on environmental phosphorus targets has triggered substantially improved P management in agriculture and lead to the instalment of P-recovery plants from municipal sludges.

STRUCTURE

With the Rapid Study and Assessment we aim at a short paper of some 8000 words very much in the style of a Perspective paper. The structure of the paper is still to be determined.

Overall, we will take a systems' approach. Indicators and targets are typically formulated for and by a particular sector, problem area or science field. Rarely are targets formulated in a total systems' context and even less so in a dynamic systems' context. Figure 4 tries to capture the SDG system in a coupled Earth-Production and Social system view. In Figure 4 we also distinguish between impact, metabolic and resource scarcity targets. In such a system's view resources play multiple roles and resource specific goals can either be directly or indirectly formulated to ensure sustainable resource management. A scarcity target could for example relate to an environmental flow criterium of a particular river system or a minimum total reserve requirement of the sum of global geological phosphorus reserves. An impact target could be formulated by a Mean Species Abundance (MSA) indicator for a global biodiversity target (potentially related to an ecosystem function) and a typical example for a metabolic target would be a recycling rate for a specific material or a land use (intensity) indicator per capita. All of these targets relate to resources, however, in a functionally very different manner in a dynamic systems' setting. In order to coordinate activities that ensure the sustainable management of resources (by reaching multiple (SDG type) goals) a system of indicators, milestones, and targets should be investigated in order to arrive at a delivery system that co-ordinates behavioural, economic, regulatory and other policy measures. Just like in cybernetic control we need to distinguish between threshold/reference targets (e.g. minimum scarcity, maximum impact), and controllers (maximum/minimum metabolic rates e.g. zero net GHG emissions by 20XX).

Taking a total systems' view it appears apparent that the IRP might want to perform in-depth analysis of different target formulation constellations in the form of impact, metabolic and scarcity targets in order to derive a consistent and robust set of targets that ensure sustainable resource management under various socio-economic development conditions.

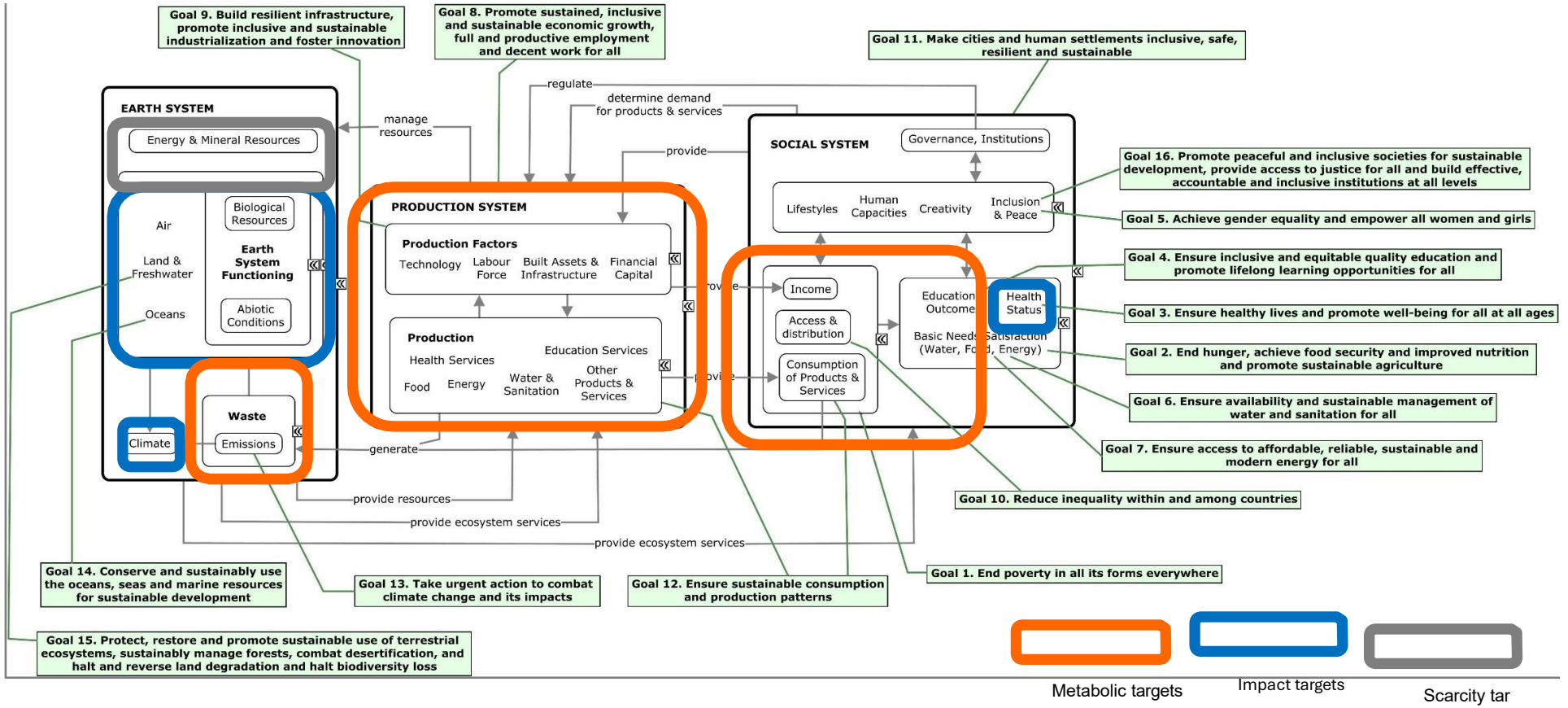


Figure 4: *SDGs (and its targets) are written from many different perspectives, representing diverse fields of science and policy. Earlier attempts to conceptualize interactions between SDGs do it at the level of goals or targets ignoring the underlying dynamics, that result in linkages representing mixed or indirect causality (or only correlations). Here we attempt to represent the underlying processes critical to achieving the SDGs. This concept map represents key system elements and relationships between them. Modifying the traditional sustainable development Venn diagram (environment, society, economy) we propose the three key interacting modules: Earth system, production system and social system. This system representation reflects to structure of the IRP modelling system. The Earth system encapsulates the biotic and abiotic resources and conditions animated by the Earth system functioning. It also includes waste dumped from the production processes including greenhouse gases emissions that affect climate and other aspects of its dynamics. The production system represents interactions between production factors (labor, infrastructure, technology and finance) and production, where we emphasize goods and services critical for SDGs. Within the production system the management of natural resources is also determined and can be influenced by specific institutions and governance structure within the social system. At the same time the Earth system provide resources and ecosystem services that make production possible. Consumption of produced goods and services is represented in the social system together with incomes, where both income and consumption can be distributed differently among citizens affecting, in turn, satisfaction of basic needs. These economic variables, jointly with actual institutions interact with various human and social characteristics such as lifestyles, human capital, creativity and inclusion. They also jointly determine the demand (both quantity as well as type of products) that determine the functioning of the production system. We use Orange to represents areas where metabolic targets might be most useful to be formulated, blue stand for impact, and grey for resource scarcity targets respectively. Note that target types can overlap. Source: CSIRO/IIASA workshop*

An illustrative strawman examples of various types of target formulation is as follows for the global land resource:

- Scarcity target
  - Half Earth for biodiversity as proposed by E.J. Wilson
- Metabolic target
  - Agricultural productivity to achieve 0.2 ha per capita as proposed by Bringezu
- Impact target
  - Near Zero Species extinction by year X as currently considered under the CBD

General Conclusion

- There seems to be only a small scope for the IRP to prescribe new impact or damage targets.
- Metabolic targets on a global scale and for aggregate material flows are difficult to justify as new "apex" type targets and, if then, political mainstreaming should only be pursued after in-depth analysis ideally in a broader system perspective.
- An integrated approach to coordinate the attainability of many targets appears as a natural competitive advantage for the IRP. The set of IRP targets should cover those related to international environmental conventions. This approach would combine the IRP's ability to integrate and coordinate multiple targets, set and agreed to by Parties to international environmental conventions with IRP relevant bottom-up target setting assessements on resource efficiency and circularity.
- Following the multi-layered approach of the planetary boundaries, climate and biodiversity are the two targets ensuring Earth system integrity while subordinated targets are of more regional / local nature (e.g. water availability and quality, N&P pollution). Certain chemical pollutants and plastic targets might also be formulated for their global impacts, which, however, do not appear as threatening the Earth system integrity.
- Following a thorough quantitative assessment - using the IRP modelling cluster - of an array of multi-layered impact targets it should be possible to formulate temporary milestone targets for metabolic rates (e.g. flow, stock, footprint, and recycling targets, water efficiency, land sparing). Such targets should be revised based on latest evidence of feasibility (technological innovation) and new knowledge about impacts and technologies in follow-up workstreams by the IRP and others.
- The most immediate target formulation the IRP might want to consider is assessing a number of resource scarcity targets (e.g. minimum environmental flows in rivers, minimum global P reserve). A clear set of principles & criteria to define such targets should be developed first before assessment

BUDGET

Support staff for each of the 3KPIs x 30	90K
Travel and other	10K
Secretariat report publishing/printing and travel	50K
Total	**150K**

URGENCY

There is urgency with the proposed Rapid Study and Assessment as it is necessary input to the scenario formulation and scenario storylines of the modelling workstream.

COMPLEXITY

The Rapid Study and Assessment will have to go through consultation with panel members as well as steering committee. Therefore, it is suggested to keep the central paper short enough to allow for meaningful input. Some of the more detailed matter will have to be referred to in supplementary material.

EXISTING KNOWLEDGE BASE

There is a large knowledge base within the panel on the matters of sustainability targets as well as outside the panel. Reconciling the complexity of the external knowledge base on SBTs will be the first step in the proposed exercise.

POLICY RELEVANT QUESTIONS

The issues and questions laid out in section 7 already provide a succinct definition of the policy questions to be answered by this rapid assessment study. In addition, we will also provide answers to the following two issues:

1) For which resources are apex targets formulated and under which evidence base should new resource apex targets be introduced?
2) If and how can metabolic targets contribute to ongoing international policy processes to ensure societal sustainability criteria?

ADDED VALUE

The IRP has branded itself as a multi-sector/resource assessment panel. Many resources target formulations are in flux yet there is little coordination between specialized resource target formulating international processes. The IRP can serve a crucial function of integration and potentially gap filling of SBT.

AVAILABLE EXPERTISE

IRP members who have relevant expertise and have shown interest in being involved in the production of this Rapid Study and Assessment report. Currently, it is envisaged that Stefanie Helweg, Michael Obersteiner and Helga Weisz will form the core team to produce a first draft for consultation. We plan recruit an internal advisory group to collect inputs to the drafting of the paper. There has been interest in joining the consultation process from inter alia Stefan Bringezu, Paul Ekins, Heinz Schandl, Marina Fischer-Kowalski, Anu Ramaswami and Paul Lucas. There will be an invitation to Panel members to join this group.

SCALE OF POTENTIAL IMPACT AND BENEFICIARIES

Impact and beneficiaries are primarily the IRP in the first instance. It is also anticipated that the Rapid Study and Assessment will be very much welcome by a much wider community as an integrative framing paper.

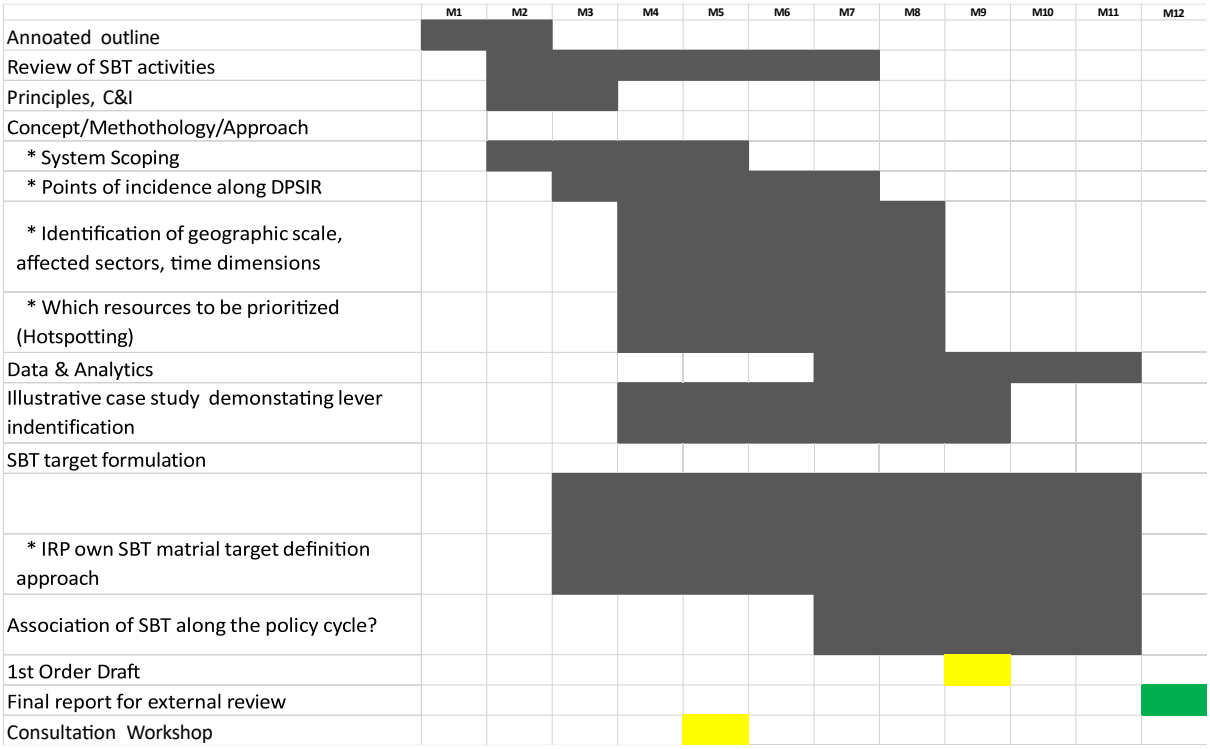
PROPOSED LEAD AUTHORS

The coordinating lead authors of the report will be Stefanie Hellweg, Michael Obersteiner and Helga Weisz.

OUTREACH AND DISSEMINATION

No specific outreach or dissemination activities are currently foreseen apart from publication of the report through the IRP website and in addition as a Perspective type paper in a leading academic journal.

WORK PLAN INCLUDING TIMELINE



TERMS OF REFERENCE

IRP Report on:

Advancing the Circular Economy in Consumer Electronic Markets

Contents

1 Context and Purpose

1.1 Rationale

The United Nations Environment Programme (UNEP) and the International Resource Panel (IRP) are deeply involved in studies that promote a decoupling of economic growth from environmental degradation. Achieving sustainable development as global populations continue to grow inherently requires such decoupling. In effort to contribute to the development of sound, science-based policy towards decoupling, the IRP has produced several reports that make clear the relationships between industrial processes in material and product manufacturing and their impacts on economic and environmental outcomes. Common amongst this work is the recognition of a necessary shift in life cycle considerations to achieve efficient and sustainable use of resources. In some cases, this shift requires rethinking and redesigning structural models for growth from linear and consumption-based to circular and regenerative.

The IRP's 2018 report *Redefining Value: The Manufacturing Revolution*[1] investigates the potential for industrial circularization through the lens of value-retention—the notion that circular models can be

[1] IRP (2018). *Re-defining Value – The Manufacturing Revolution. Remanufacturing, Refurbishment, Repair and Direct Reuse in the Circular Economy.* Nabil Nasr, Jennifer Russell, Stefan Bringezu, Stefanie Hellweg, Brian Hilton, Cory Kreiss, and Nadia von Gries. A Report of the International Resource Panel. United Nations Environment Programme, Nairobi, Kenya.

more economically efficient than incumbent linear systems. This approach addresses the policy, technology, and logistics models that serve as fundamental drivers of business decisions, and therein provides not only an assessment of current circular systems, but a roadmap for enabling decoupled growth by alleviating barriers that impede uptake of value retention processes (VRPs), namely remanufacturing, refurbishment, comprehensive refurbishment, repair, and direct reuse. To achieve this end, the 2018 report uses case studies to demonstrate the economic, social, and environmental benefits of industrial circularization across the product spectrum.

However, the report focuses on cases where VRPs are somewhat accepted in industrial practice—automotive components, heavy-duty and off-road (HDOR) equipment, and commercial digital printers. This focus on commercial, business-to-business product markets provides only a partial understanding of how circularity and resource efficiency can support sustainable development. Specifically, there remains a significant gap in understanding around how circular economy principles and their potential benefits might apply to consumer products industries—a significant element of the global industrial economy. A comminiqué from the G7 Environment Ministers' Meeting on 5-6 May 2019 invites the IRP to address this gap by "continu(ing) its work on VRPs…notably by addressing their potential in the consumer goods sector" (¶17). Accelerating demand in these sectors, considered in light of the characteristics many consumer products categories exhibit (e.g. shorter lifecycles, rapid technology change rates, and lack of repair options) highlights how critical decoupling growth from environmental impact is to sustainable development. However, these conditions concurrently suggest that VRPs in consumer product sectors may require greater change in product strategies and business to consumer models, and thus be markedly more difficult to achieve.

The IRP endeavors to "*contribute to a better understanding of how to decouple economic growth from environmental degradation"* and propose policy and approaches that advance "*the sustainable use of natural resources"* in that pursuit (IRP Mission Statement). Therefore, an expansion of the Panel's work on circular economy research to consumer product sectors is both warranted by the IRP's mission and central to its efforts to inform policymakers and business leaders with data-driven, change-enabling science.

1.2 Key Objective

The need to create more sustainable industrial models is ubiquitous across sectors, and resource efficiency and circular economy principles are commonly proposed as potential means to achieve this end. However, scientific analysis of the viability of, as well as barriers to and opportunities in resource efficiency and circular economy policy development remains weak in sectors where such models have not been historically present. The ultimate objectives of this study are therefore to identify specific methods and approaches to expand the role of VRPs in consumer electronic product (CEP) markets, model the potential economic value and environmental impacts of expanding VRPs to these sectors, and develop guidance for policy and decision makers that supports this growth.

To achieve this, this study will provide an analysis of how technology, market, and logistics-related enabling factors affect the viability of resource efficient and circular models in these sectors. Using product and market cases that reflect broader industry conditions in developed and developing contexts, this work aims to investigate where there is opportunity for VRP uptake; what technical, logistical, policy, and market conditions are necessary to enable it; and what the benefits of such circularization might be in terms of material and energy consumption, waste and emissions generation.

Analysis of these values will highlight conditions that optimally enable the growth of VRPs, providing scientific basis for higher-level policy recommendations related to barrier eliminations, and business models.

1.3 Target Audience & Intended Outcomes

These recommendations are intended to be used by both policymakers to guide the development of instruments that support resource efficiency and circular economy implementations, as well as business leaders to adapt their activities to newer circular and more effective and sustainable models. By illustrating the practical potential and technical feasibility of a circular and efficient economy, this work will provide scientific justification for policy criteria and business decisions relating to energy, material, and waste. Likewise, this study will provide a validated approach for integrating VRPs as a business activity, supporting the growth of VRPs in consumer product sectors and thereby facilitating the actionable shift towards a more circular and resource efficient economy. Beyond its value to businesses, this work can also provide objective information to consumers about the implications of their product choices. A more informed customer base can in turn drive industry action, extending the value of this study throughout the industrial economic ecosystem.

2 Scope

2.1 Market Sectors & Product Classifications

Consumer electronic products manufacturing and retail comprise significant portions of global industrial economic productivity; worldwide estimates suggest industry revenues will reach $1 trillion USD in 2020, and will grow to $1.5 trillion USD by 2026.[2] Consequently, the manufacture, distribution, use, and end-of-life (EOL) disposition of products in these sectors are responsible for considerable social and environmental impacts, from material waste and toxicity (35 MMT to landfill per year)[3], greenhouse gas (GHG) emissions (793 MMT CO_2e per year and growing)[4], material depletion, and land use change to the adverse implications of these effects on human health and development.

Sustainable materials management and resource efficiency are, however, not novel concepts in this sector. Industry innovators have long sought to optimize variables like material and energy consumption under the lens of risk management and cost mitigation, driven simply by good business. However, incumbent industrial practices—even after decades of incremental improvement—still fail to create conditions that are comprehensively sustainable. Persistent linear industrial models remain at odds with the finite nature of the resources upon which industry relies, and indeed directly cause environmental degradation that destabilises many system elements, from material supply to global logistics. The implications of this paradox threaten to impede sustainable development and increase global socioeconomic risks associated with climate change.

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[2] Global Market Insights (2020). Consumer Electronics Market Size by Product & Application: Industry Analysis Report, Regional Outlook, Growth potential, Competitive Market Share & Forecast, 2020-2026). https://www.gminsights.com/industry-analysis/consumer-electronics-market

[3] Baldé, C.P., Forti V., Gray, V., Kuehr, R., Stegmann,P. (2017). The Global E-waste Monitor – 2017, United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Vienna. Estimates only 20% of e waste is properly recycled.

[4] CTA (2020). "Global Year-to-Year Emissions Summary" in 2019 Industry Report on GHG Emissions. For year 2017, includes Scope 3 (value chain, material) from 45 global CTA members. Global industry emissions trending upwards at +2.7%/year https://cdn.cta.tech/cta/media/media/resources/cta_ghg_report.pdf

It is thus clear that much work is needed to advance circularity efforts in order to create more sustainable, and resource efficient societies worldwide. However, the consumer products sector in general encompasses a vast array of product types. In addition to durables and hard goods, consumer products include intermediate products such as textiles and apparel (where material recycling is often more appropriate than VRPs), sports and leisure equipment (where direct reuse in secondary markets is most viable), and consumables like food, detergents, etc. (where circularity is less technically sensible than reduction and consumption efficiency). Consequently, circular economy research aimed at consumer products industries cannot provide one-size-fits-all solutions.

To address this challenge, this study will focus on a representative subsector of consumer goods that holds particular importance to sustainable development—consumer electronic products (CEPs). This focus is relevant because the per-product impacts of CEPs are especially high relative to the broader consumer sector. Specifically, CEPs often require critical raw materials[5], create high energy demand in manufacturing and use, and become complex and hazardous waste streams at EOL. Further, in the age of information, access to CEPs is critical to the techno-economic and thus social development of many developing societies. Incumbent resource efficiency and circular strategies employed in CEP sectors—including recycling and resale in secondary markets—do not adequately manage these issues, and leave challenges in waste disposal (e.g. unusable or toxic materials) virtually unaddressed.

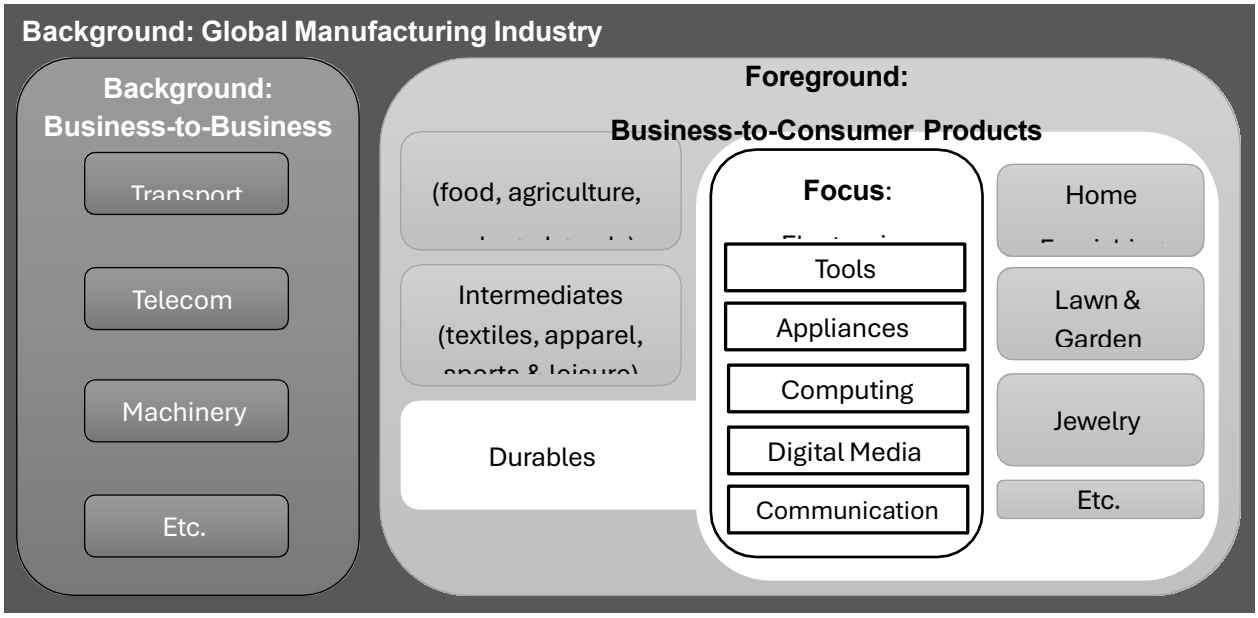

Figure 1: *Project scope relative to broader industry. Example categories highlighted are illustrative; definitive product categorization & selection will be a product of Part I of the study outlined below.*

Myriad CEP classification systems exist in both industrial and academic literature, including grouping by functional utility, material composition, and size. The Waste Electrical and Electronic Equipment (WEEE) Directive provides a product grouping framework that considers each of these criteria, but also takes into account the risks and challenges associated with particular materials and design choices at EOL, and their impacts on post-consumer disposition. Because materials, design, and EOL

[5] EC. (2020). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Critical Raw materials Resilience: Charting a path towards greater security and sustainability*. https://doi.org/10.1017/CBO9781107415324.004

disposition factors are critical to enabling VRPs and the circular economy at large, this study will use the WEEE Directive product categories to guide research and analysis (Table 1). Although the Directive is not universally adopted for regulatory action, its robust and logical classification framework rmains relevant for the scope of this work, and is used only as a specific conceptual guide.

Table 1: *WEEE Directive product categories. This framework includes both industrial grade equipment and CEP.*

Category	Definition	Examples	Excludes
Temperature Exchange Equipment	Substances other than water used for cooling, heating, and/or dehumidifying	Refrigerators, air conditioning, heat pumps	Ventilation equipment, coil-based heaters, water-based radiators
Screens, Monitors, & Screen-Containing Equipment	Provides images & information on an electronic display, screen area > 100cm2	Monitors, laptops, tablets, e-readers (CRT, LED, LCD, or otherwise)	IT equipment (Cat 6), equipment with screens that falls in other categories (e.g. smart fridge, ATM, industrial machinery, medical devices, printers/copiers)
Lamps	Equipment for the generation of light	Fluorescents, HID lamps including pressure sodium and metal halide, LED	Luminaire (an apparatus that distributes, filters, or transforms light)
Large Equipment	Any external dimension > 50cm when measured in status ready for use; can include IT/Telecom	Washers/Dryers, dish washers, stoves, musical equipment, printers, servers, medical devices, vending machines/ATMs, PV panels, IT/Telecom equipment, amplifiers, tools, toys, sports & leisure equipment, generators.	Refrigerated vending machines (Cat 1), large screens (Cat 2), large lamps (Cat 3)
Small Equipment	All dimensions < 50cm when measured in status ready for use; excludes IT/Telecom	Vacuum cleaners, microwaves, fans/ventilation, toasters, clocks, shavers, scales, radios, cameras, musical instruments, tools, toys, sports & leisure, smoke detectors, thermostats, small medical devices	Equipment in other categories (e.g. mobile phones, routers, GPS in Cat 6).
Small IT and Telecom Equipment	IT--collecting, transmitting, processing, storing, and showing information Telecom--transmit signals (voice, video, data) over distance. All dimensions > 50cm	Mobile phones, GPS equipment, calculators, routers, personal computers, printers, telephones	IT equipment with screens >100cm2 (Cat 2)

It should be noted that WEEE categories include both industrial (commercial) equipment and CEP. While this research and its associated economic and environmental models will focus on CEP sectors,

it is conceivable that technical and policy recommendations revealed through this work may similarly apply to industrial electrical and electronic equipment.

2.2 Geographic Coverage

While markets for CEP span the globe, realities of scale and data availability require tailoring the scope of this study to align with its key objective and the underlying mission of the IRP. In accordance with the goal of advancing resource efficiency and the circular economy through VRPs as advanced and sustainable manufacturing business models, this study will highlight CEP cases from a nation where both CEP manufacturing and use are significant elements of the industrial economy. In this case, the United States (US) is proposed as a case nation for the significance of its CEP markets, data availability, and access to major manufacturers with global reach (e.g. Apple, Dell, etc.). Further, in effort to explore the role of VRPs as an enabler of sustainable development, this study will also examine CEP cases from a developing nation where consumer use patterns create favorable market conditions for product life extension. In this case, we suggest Ghana as a representative nation with growing involvement in secondary CEP handling and emerging markets in the global landscape.[6]

These case nations are intended to provide sound representations of industrial, economic, and environmental conditions in developed and developing markets, respectively. As a result, technical conclusions and corresponding policy recommendations developed from case-specific models may well serve as functional guidelines in other contexts that share characteristics of industrial infrastructure, policy frameworks, and customer/ market behavior. To investigate such applicability, assessment of policy recommendations and their effect on VRP uptake and impacts may be performed on common reference nations in both developed and developing contexts. Should any stakeholders wish to perform detailed analysis in additional geopolitical contexts, VRP uptake and impact upscaling models developed for this study will be designed to maximize usability.

2.3 Value Retention Processes

The 2018 IRP report on *Redefining Value*[1] highlights remanufacturing, refurbishment, repair, and direct reuse as VRPs that are central to driving more circular economies (Figure 2). This work will expand on the 2018 study using its standardized process definitions, but will focus specifically on how these processes are and can be adapted to CEPs. To that end, this study will consider the following:

1) **Remanufacturing** (adapted from *Redefining Value* Ch.2.5.2): A standardized industrial process in which whole product or component cores[7] are restored to original as-new condition and performance or better. Remanufacturing processes follow technical specifications for engineering, quality, and testing standards, and typically yields fully warrantied products.
2) **Comprehensive Refurbishment,** (*Redefining Value* Ch.1.5.5): Refurbishment processes that take place within industrial or factory settings, often under the auspices of original equipment manufacturer (OEM) business models, with a high standard and level of refurbishment.
3) **Refurbish** (UNEP/CHW.13/4/Add.2)[8]: Modification of used or waste equipment to increase or restore its performance and/or functionality or to meet applicable technical standards or

[6] Final selection of case nations will be subject to data availability, policy relevance, and Panel approval.
[7] A used product or part intended to be remanufactured. A core is not waste or scrap and will not be reused prior to remanufacturing.
[8] Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal 2017, Working Document UNEP/CHW.13/4/Add.2

regulatory requirements, with the result of making a fully functional product to be used for a purpose that is at least the one that was originally intended.

4) **Repair** (Appendix II, UNEP/CHW.13/4): Fixing of a specified fault in a used or waste product and/or replacing defective components in order to make the wate or used product fully functional to be used for its originally intended purpose.

5) **Direct Reuse** (Appendix II, UNEP/CHW.13/4): The using again of a product that is not waste for the same purpose for which it was conceived without the necessity of repair or refurbishment.

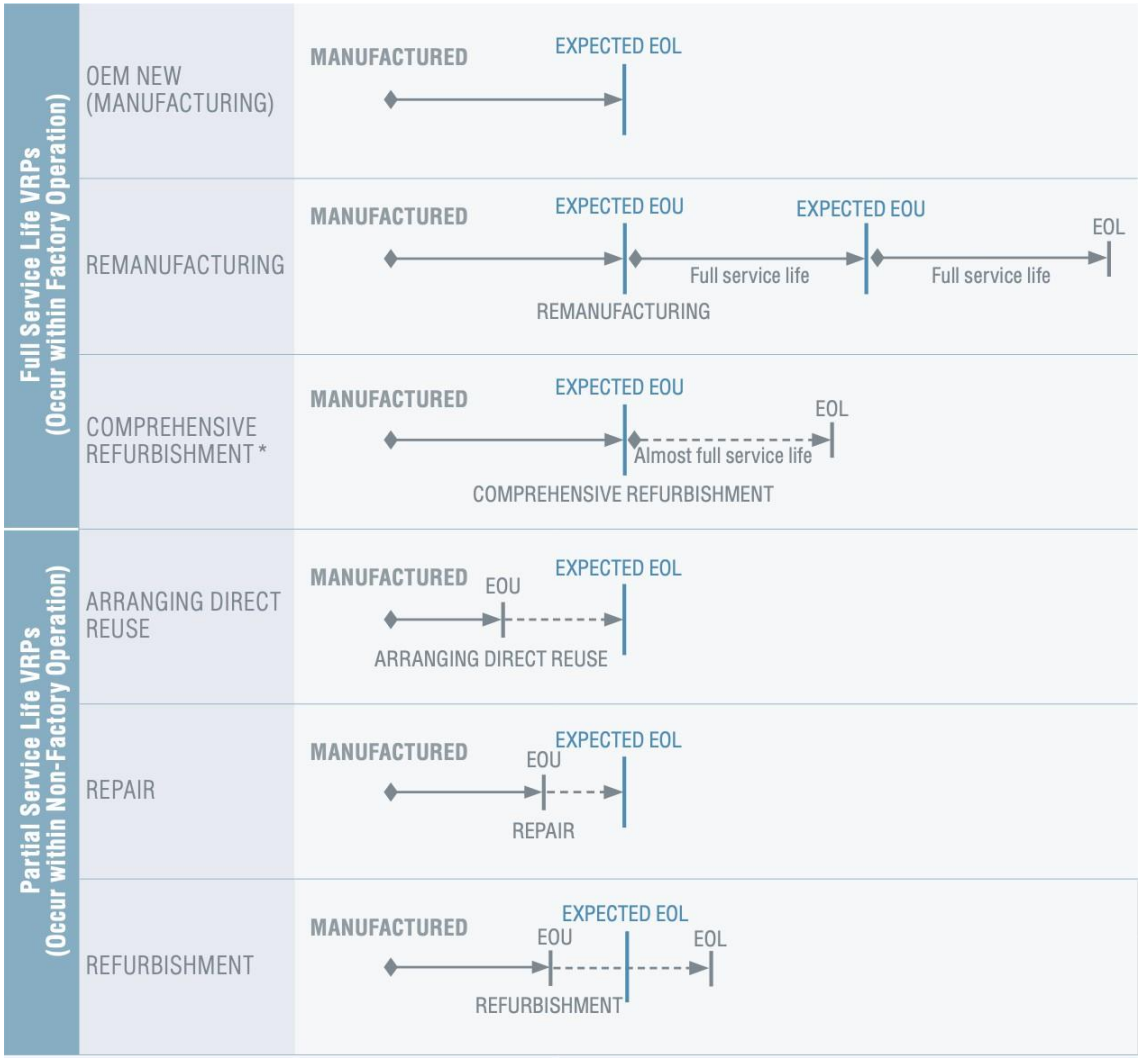

Figure 2: *VRPs by point of deployment relative to end-of-use [EOU] and effect on service life, adapted from IRP (2018).*

Notably, recycling is not considered a VRP; although recycling recovers valuable material, it does not capture value embodied in the processes required to establish the physical form and functionality of finished components. However, because recycling in many cases plays an active role in the EOL disposition of CEP, this study will examine the implications of recycling on CEP market economics and resource efficiency, and use this assessment as a frame of reference to evaluate potential increases in benefits through adoption of VRPs. Likewise, it must also be acknowledged that VRPs in some cases cultivate only selected components of EOL products, and thus generate components and

material that cannot be recirculated into VRP streams, but must still be managed. To address this, the study will also examine the impacts of increasing VRPs in CEP sectors on existing recycling streams in a circular ecosystem and the implications of this relationship on systemic resource efficiency.

3 Approach

A robust and conceptually logical approach is essential to ensure that this study produces concrete recommendations. The constituent elements of a comprehensive plan —technology, business models, policy, and customer behavior—are at once individually complex and inextricably interdependent. Understanding the dynamic relationships between these elements is therefore crucial to discovering where change may be injected in order to have the greatest return in economic, environmental, and social benefits. In order to make this analysis accessible to the typically non-technical expert agents whose actions ultimately determine the future of VRP adoption, the proposed approach of this study is comprised of five key parts in ascending order of complexity and scale.

3.1 Part I: Market Assessment & Material Flow Analysis

Part I conducts an assessment of CEP sectors to identify product types with critical raw material, energy, waste, and emissions impacts where the introduction of VRPs may have significant benefits. A baseline assessment of CEP flows through production (inflows), use (stocks), and EOL (outflows), supported by market data on value ($USD), and impacts (material, energy, waste, and emissions) will highlight key product types both globablly and in each case study country. Connecting this data to information on the market life (time in use) of key product types will in turn highlight relationships between product durability characteristics and consumption/waste patterns that may be critical considerations toward scaling life cycle extension and value retention. In addition to product and material flows, Part I will provide a first-level assessment of incumbent linear value chains and information flows in highlighted CEP categories. These assessments will establish the business and policy characteristics of the landscape in which subsequent analysis of VRP fit will be explored.

3.2 Part II: Identification of Potential VRP Case Models

Part II identifies a set of product-level VRP approaches—including inherent technologies, business models, logistics systems, and policies—that can be applied to key CEP categories to improve resource efficiency and increase circularity. These approaches and their parameters will be based on an investigation of successful VRP strategies in other product sectors and conceptual models of their adaptation to and application in CEP market settings identified in Part I. This will include VRP approaches from both within case nations as well as other global markets CEP manufacturers may serve. A feasibility assessment covering technology availability, economics, environmental impacts, and market acceptance (i.e. consumer behavior influcences) of VRPs relative to incumbent linear production and waste/recycling baselines will be applied to each VRP approach. Results of this assessment will be used to create case models that match VRP activities to key products/categories identified in Part I in a manner designed to maximize potential economic and environmental benefits. Assessment results will also offer a first level view of barriers that may inhibit VRP integration.

3.3 Part III: VRP Case Model & Barriers Analysis

Part III provides an analysis of proposed VRP case models to investigate how they might fit into incumbent markets, where barriers to implementation exist, and how strongly such barriers might affect uptake. Bottom-up lifecycle accounting of costs, inputs, energy, materials, and

emissions will create a product-level unit-process data inventory for each VRP case model that describes high-level barriers identified in the Part II feasibility assessment in greater detail. Additional impacts, such as material criticality, waste, and toxicity, will be considered if accounting reveals significant challenges or potential for improvement. These cases will then be used to create a systems-level understanding of linkages between barriers and their root causes—areas such as design approach, process technology, life cycle duration, product technology change rate, use and ownership patterns, information flows, and operational logistics—that affect economic viability, environmental preferability, and ultimately implementation potential. Critical to this assessment is consideration for the relationships between VRPs and net product use, as well as the relative benefits of VRPs versus those of technology evolutions in new products that improve efficiency—both of which significantly affect a model's net environmental profile. Analysis of these characterizations will illustrate which barriers have the greatest influence over material reuse potential, component upgradability, lifecycle durability, and other factors that affect overall environmental performance. Key barriers identified here will in turn become adjustable constraints in Part IV, which models the influence of different scenarios of barrier alleviation on the economic and environmental performance of VRPs. Importantly, this analysis may reveal cases where application of VRPs does not produce net benefit. In such cases, the conditions that create variability will be considered as barriers for potential alleviation modeling.

3.4 Part IV: Barrier Alleviation & Uptake Modeling

Part IV uses system dynamics modeling to project the uptake and economic and environmental performance of VRP case models under different scenarios of barrier alleviation. Part IV will create alleviation scenarios for key barriers related to specific VRP case models identified in Parts II & III. A system dynamics model will simulate how different levels of barrier alleviation affect VRP case model uptake and impacts at the firm level, and thus shed light on the costs, benefits, and technical feasibility of achieving such a shift. A focus on inputs (labor, energy, new material, and post-consumer EOL products) versus outputs (waste, material to recycling, emissions, and finished extended-life products) will demonstrate potential improvements in resource efficiency and their implications on economic and environmental performance. A robust baseline case model for CEP recycling and waste disposition pathways will serve as the basis for comparison. Modeling will also aim to capture reciprocal effects of increasing VRP uptake on both recycling waste management streams as a part of an integrated circular ecosystem. Results of this modeling will provide product- and firm-level performance assessments that will serve as the basis for a larger discussion on sector-, industry-, and economy-level implications in Part V. If and where results suggest a particular VRP case model is both economically viable and environmentally preferable, Part VI will examine potential policy measures that may achieve the modeled conditions of the corresponding alleviation case.

3.5 Part V: Estimation of Economic & Environmental Implications

Part V upscales product- and firm-level results to project industry- and economy-level implications of VRP uptake scenarios in terms of revenue, jobs, and environmental impacts. A consistency in modeling with the ongoing work of the GRO2023 working group is aimed for, including the definition of storylines, scenario assumptions, and the use of models and modeling approach. In this context, Part V will extrapolate product- and firm-level economic and environmental impact assessments from Parts III and IV, respectively, to the industry scale for each case nation, providing a high-level view of the value of VRPs to industry actors. Additional assessment of these impacts relative to the broader industrial economy in each case nation will illustrate the potential benefits of a

circular shift at a scale most familiar to policymakers and relate the value of VRPs to the pressing challenges of global climate change. This scale-up will consider the role and influence of important economy-level factors such as rebound effects and sensitivity across logistics, technology, and market enablers. Likewise, both synergies and trade-offs between and among environmental and economic impacts will be highlighted to support policy analysis in Part VI. In effort to illustrate potential additional benefits (rather than savings alone) offered by VRPs, economic and environmental estimations will use existing CEP recycling streams—rather than new production—as a frame of reference for comparative analysis. Projections under business-as-usual (BAU, e.g. low), medium, and theoretical high levels of VRP uptake will make clear both the potential benefits of a circular shift and the consequences of inaction. Careful examination of case nation traits relating to CE enablers can suggest whether similar outcomes can be expected in different national contexts.

3.6 Part VI: Policy Recommendations

Part VI interprets results from Parts II-V to highlight the most critical barriers to alleviate in order to enable successful VRP implementation and uptake in CEP sectors, breaking down constituent elements of these barriers to suggest policy measures that best address them. Recommendations will cover high-impact points in technology, logistics, business models, and market arrangements that influence the success and relative benefit yield of VRP solutions. Such points may include discussion around market access, producer responsibility, information flows, product and hazardous waste handling, infrastructure development, and international trade barriers. Analysis of potential policy measures in these areas will consider the effects of both voluntary and involuntary mechanisms, as well as trade-offs between enabling VRPs and potential externalities imposed upon businesses and consumers. Part VI will also explore the applicability of recommendations to broader product categories and national contexts in pursuit of large-scale circular shifts. Importantly, policy analysis will explore the fit and position of potential recommendations relative to existing policy landscapes, including and especially those concerning trade, waste management, human health, and global climate change. To support this effort, this study will seek and compile perspectives from both governmental and industry stakeholders about the form and function of policy instruments, from regulation and standardization to incentive programs and industrial development investments.

Key research questions, information and data inputs, research tasks, and expected outcomes for each Part are summarized in Table 2 to illustrate logical connections and workflow between components.

Table 2: *Summary of study parts, themes, and expected outcomes*

Part	Key Question	Inputs	Tasks	Outcomes
Market Assessment & Material Flow Analysis	What are the most critical CEP categories?	- Market Data	- Volume, value, impact analysis - Market dynamics assessment	- Top three CEP categories/case study products - CEP value chain knowledge
Identification of Potential VRP Case Models	How might VRP models work in those categories?	- CEP case products - Successful VRP model knowledge - CEP value chain knowledge	- VRP model element dissection - CEP system elements analysis - Feasibility assessment	- VRP Case Models & high level barriers
VRP Case Model & Barriers Analysis	What barriers most inhibit VRP uptake in those categories?	- VRP Case Models - High level barriers - CEP systems models	- Unit-process inventory - Life cycle impact inventory	- Key barriers to VRP uptake - Impact inventory

			- System model hotspot analysis	
Barrier Alleviation & Uptake Modeling	What would the benefits of VRPs be if those barriers were alleviated?	- Key barriers - Impact inventory - Alleviation scenarios	- System dynamics description - Alleviation modeling - Impacts assessment	- Potential impacts of VRP uptake - Barrier alleviation parameters
Estimation of Economic & Env. Implications	How do estimated benefits scale at the national level?	- Impacts of VRP uptake (firm level)	- Impact scale up	- Impacts of VRP uptake (national)
Policy Recommendations	How might policy measures help alleviate key barriers to achieve those benefits?	- Barrier alleviation parameters - Impacts of VRP uptake (national)	- Policy development & implementation analysis	Policy rec's to support VRP uptake & achieve benefits

3.7 Form of Final Product

This study will produce a report that acts as both a complement and a supplement to the 2018 IRP report on *Redefining Value* in commercial product sectors. By expanding the 2018 study's focus and methods to the consumer products sector, the combination of these reports will create a more complete assessment of circular economy imperative, potential, and drivers across the industrial economy. Key takeaways from this research will be (1) a set of validated VRP case models for selected CEP sectors to inform industry development; (2) estimation of the economic and environmental benefits of increased resource efficiency offered by VRPs in CEP sectors to rationalize policy decisions; and (3) technical policy recommendations to facilitate uptake and create resilience. A content target of 100 pages is proposed, with summaries for policymakers and industry leaders respectively of approximately ten pages each.

4 Partners

This study will use perspective from a diverse set of stakeholders to ensure that models, analyses, and recommendations all reflect actual landscapes across industry, policy, society, and environment as closely as possible. To this end, the following resources for collaboration are identified based on their expressed interest, industry leadership, and/or connection to the IRP:

4.1 Industry Consultancy

Industry actors are identified as a major intended audience for this study, as the growth and success of a resource efficient and circular economy ultimately depends on their acceptance and deployment of VRPs as central tenets of business. Successful acceptance of such principles requires a diversity of voices. To that end, we propose collaboration between technology leaders in the CEP sector for whom VRPs remain underutilized, pioneers in VRP business models who can offer valuable insight on transitions, and industry advocate groups that serve as a source of authority and information for businesses on a sectoral level. Small- and medium-sized enterprises (SMEs) will also be encouraged to participate in the industry consultancy group in effort to provide insight applicable across contexts of economic makeup. Examples of prospective collaborators identified in these areas include:

- **Tier 1—CEP Manufacturers:** Apple, Samsung, Phillips, Siemens, Intel, Dell
- **Tier 2—Circular Leaders:** Caterpillar, Deere & Company, Renault, Sims Recycling Solutions, refurbed.de, ReNet Japan, ecosystem.eco
- **Tier 3—Industry Advocates:** Consumer Technology Association, International Electronics Manufacturing Initiative (iNEMI), AFNUM, Circular Electronics Parntership, World Resources Institute Platform for Accelerating the Circular Economy (WRI PACE)

Insight and data to support market assessment, case model development, and barrier analysis will be sought through direct communication and request arranged via Panel networks. Subsequently, industry feedback to support barrier alleviation modeling and policy discussions will be solicited through workshop events at relevant points in the study timeline.

4.2 Technical Research Group

The core of this work depends upon expertise from multidisciplinary research leaders. This study will take advantage of the wide variety of resources offered by IRP members, including database access, modeling expertise, and policy analysis. Section 5 outlines specific IRP contributors to each Part of the study. In similar fashion to the 2018 report on *Redefining Value,* several components of this work will be comprised of contributions toward the doctoral dissertation of one or more Ph.D. students from the Rochester Institute of Technolgy (RIT) in Rochester, New York, USA under the guidance of Panel member Dr. Nabil Nasr and doctoral advisor Dr. Michael Thurston.

4.3 Government & NGO Policy Advisory

Collaborators representing governmental leadership across national, regional, and global scales will be sought to provide guidance on specific challenges and potential solutions related to policy. This may include particular government agencies in case nations, UNEP-affiliated representatives, and international initiatives such as the Basel Convention. Similarly, non-governmental groups that provide research and insight on global economics and policy relationships—e.g. the Ellen MacArthur Foundation, amongst others— may be leveraged in the development of VRP case models and subsequent implementation and policy analyses. Connections to relevant parties will be initiated through the networks of Steering Committee and Working Group members. Insight, data, and policy perspectives may be solicited both through direct communication request and workshop participation.

5 Structure and Working Groups

The structure of this study is built around the five key parts outlined in Section 3 of this document. Research content will be preceded by introductory material that establishes the need for this work and positions it relative to existing work in the circular economy, including previous IRP reports. A proposed organization of these elements is as follows:

- Preface (1 page)
- Foreword (1 page)
- Executive Summary, including key conclusions (5-7 pages)
- List of Figures and Tables (2-4 pages)
- Glossary of Key Terms (3 pages)
- Introduction, including goal, scope, and objectives (8-10 pages)

Following this material, the report will be organized by Parts I-VI, each subsequent part building upon the results of the preceding analysis. Key questions and potential IRP working group contributors for each Part are outlined in detail below. Following chapters for Parts I-VI, a Conclusions chapter will summarize key takeaways, highlight priority targets for implementing VRPs in CEP sectors, and reiterate how this report fulfills the goals of the IRP and UNEP with respect to both resource efficiency and circular economy in general and the challenge of sustainable development at large.

Part I: Market Assessment & Material Flow Analysis (10 pages)

- Research Questions:
    - What are the most important product sectors/classes in the consumer electronics market in terms of volume, economic value, and environmental impact?
    - Who are the most important actors in consumer electronics markets, and what are their use patterns?
    - What do value chains and material/information flows look like in incumbent models?
    - How do the most important sectors differ across developed and developing nations?
- Potential Contributors: Seiji Hashimoto, Anthony Chiu, Bing Zhu, Ester van der Voet, data and information from Industry Advisory

Part II: Identification of Potential VRP Case Models (15 pages)

- Research Questions:
    - What kinds of VRP models are applicable to CEP markets?
    - Are potential VRP applications in CEP markets environmentally and economically viable?
    - What functional adaptations would enable implementation in case product categories?
- Potential Contributors: RIT, Mitsutaka Matsumoto, Bing Zhu, Markus Reuter, Antoinette van Schaik, insight from Industry Advisory

Part III: VRP Case Model & Barriers Analysis (20 pages)

- Research Questions:
    - What existing technology, processes, business and logistics models, or policy supports beneficial VRPs in case study product areas currently? What elements of successful VRP cases enable the most benefits?
    - What elements of incumbent CEP systems inhibit economic and environmental preferability of VRPs, and to what extent?
        - E.g. material management regulation, core availability, use cycle and durability characteristics, market interest and acceptance, OEM-third party relationships
    - What barriers must be eliminated in order to grow market access for VRPs?
- Potential Contributors: RIT, Mitsutaka Matsumoto, Markus Reuter, Antoinette van Schaik, Stefan Bringezu, feedback from both Industry and Policy Advisories

Part IV: Barrier Allevitation & Uptake Modeling (20 pages)

- Research Questions:
    - How can we mathematically represent CEP markets in terms of behaviors, barriers, and decisions that determine stocks and flows of both new and VRP products?

    - Within these market dynamics models, how do VRP Case Models perform in various scenarios of barrier alleviation, and are there economic and environmental benefits at the product and firm level?
    - What barrier alleviations (in design, technology, logistics, policy, consumer dynamics, etc.) offer the greatest return in enabling VRPs, in terms of uptake and net benefits?
- Potential Contributors: RIT, Edgar Hertwich, insight & feedback from both Industry and Policy Advisories

Part V: Estimation of Economic & Environmental Implications (15 pages)

- Research Question:
    - How does VRP uptake affect economic and environmental performance across at the national economy scale? What are the extrapolated implications at the global scale?
- Potential Contributors: Ester van der Voet, Stefan Bringezu, Markus Reuter, Antoinette van Schaik, Keisuki Nansai, Edgar Hertwich, RIT

Part VI: Policy Recommendations (10 pages)

- Research Questions
    - What are the key levers (i.e. barriers) in technology, logistics, market dynamics, etc. that most influence environmental and economic outcomes of VRP uptake in CEP sectors? (This is answered in part by modeling results from Part IV).
    - How well do current policy structures address these issues?
    - What new policy measures (e.g. in technology development, producer responsibility, market structure, international trade, etc.) can be used to create favorable conditions that better alleviate these barriers?
    - What types of actions and relationships are required to develop and deploy such policy measures?
- Potential Contributors: Hans Bruyninckx, Peder Jensen, broader group discussion, insight & feedback from both Industry and Policy Advisories

Conclusions (2 pages)

Data & Appendices (as needed)

Summary documents for policymakers and business leaders respectively will be developed from the full study, and are targeted at approximately 10-15 pages each. These documents will provide highlights on critical CEP categories, VRP approaches and their barriers, the benefits of VRP implementation, and policy measures towards barrier alleviation in that pursuit. Material surrounding complex ethodological and modeling efforts will not be included in summary documents, but references to appropriate sections of the complete study will be made.

6 Workplan and Timeline

Tasks	**Target** (Months)	**Status** (April 2021)
Final Approval of ToR	March 2021	Complete
Market Assessment and Material Flow Analysis	Months 1-3	-
Identification of VRP Case Models	Months 2-4	-
VRP Case Model and Barrier Analysis	Months 5-7	-
Barrier Alleviation & Uptake Modeling	Months 7-11	-
Economic & Environmental Implications	Months 12-14	-
Policy Analysis & Recommendations	Months 14-16	-
First draft assessment report ready for peer review	Months 17-20	-
Peer review feedback and discussion	Month 21	-
Final assessment report addressing peer review comments	Months 22-23	-
Final version of summary for policy makers	Months 23-24	-
Final version of summary for business leaders	Months 23-24	-
Final version of factsheet	Months 23-24	-
Power point presentation of findings	Months 23-24	-

7 Budget

Budget Category	Year 1	Year 2	Total
Research Staff (2 staff)	$72,749	$74,893	$147,642
Graduate Student	$30,000	$30,000	$60,000
Workshops	$0	$11,680	$11,680
Publication Costs	$0	$30,000	$30,000
Total	**$102,749**	**$146,573**	**$249,322**

8 Existing Research

8.1 Market Assessment & Material Flow Analysis

Babbitt, C., Althaf, S., Chen, R. (2017). “Summary Report of Phase 1 Research: Development of a Sustainable Materials Management Modeling Framework and Baseline Model Results,” *Sustainable Materials Management for the Evolving Customer Technology Ecosystem.* Rochester Institute of Technology, Golisano Institute for Sustainability.

CEC. 2016. *Quantitative Characterization of Domestic and Transboundary Flows of Used Electronic Products*. *Case Study: Used Computers and Monitors in North America*. Montreal, Canada: Commission for Environmental Cooperation. 126 pp.

Glöser-Chahoud, S., Pfaff, M., Walz, R., Schutmann, F. (2019). "Simulating the service lifetimes and storage phases of consumer electronics in Europe with a cascade stock and flow model," *Journal of Cleaner Production,* 213:1313-1321.

Grand View Research, (2018). *Market Analysis Report: U.S. Household Appliances Market Size, Share, & Trends Analysis Report, By Product Type, Distribution Channel, Competitive Landscape, and Segment Forecasts, 2018-2025.*

Hertwich, Edgar G., Saleem Ali, Luca Ciacci, Tomer Fishman, Niko Heeren, Eric Masanet, Farnaz Nojavan Asghari, et al. 2019. "Material Efficiency Strategies to Reducing Greenhouse Gas Emissions Associated with Buildings, Vehicles, and Electronics—a Review." *Environmental Research Letters* 14 (4): 043004. https://doi.org/10.1088/1748-9326/ab0fe3

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IRP (2017). *UN Environment Programme International Resource Panel Global Material Flows Database. https://www.resourcepanel.org/global-material-flows-database*

IRP (2020). *Consumer Electronics Remanufacturing Database Repository.* Compilation of associated global and regional data sources.

Mangold, J., Cristobal, K., Mars, C., Dornfeld, D. (2015). "Assessment Framework and Material Flow Analysis fo Material Recovery Facilities Within the U.S. to Track Consumer Electronics by Product Category," *Procedia CIRP: 22nd Conference on Lifecycle Engineering.* 29:556-561. https://doi.org/10.1016/j.procir.2015.02.202

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8.2 Identification of Potential VRP Case Models

TBD

8.3 VRP Case Model & Barriers Assessment

Atlason, R.S., Giacalone, D., Parajuly, K. (2017). "Product design in the circular economy: Users' perception of end-of-life scenarios for electrical and electronic appliances," *Journal of Cleaner Production,* 168:1059-1069. https://doi.org/10.1016/j.jclepro.2017.09.082

Hischier, R., Wäger, P., Gauglhofer, J. (2005). "Does WEEE recycling make sense from an environmental perspective? The environmental impacts of the Swiss take-back and recycling systems for waste electrical and electronic equipment," *Environmental Impact Assessment Review,* 25(5):525-539.

Hobson, K., Lynch, N., Lilley, D., Smalley, G. (2018). “Systems of practice and the Circular Economy: Transforming mobile phone product service systems,” *Environmental Innovation and Societal Transitions,* 26:147-157. https://doi.org/10.1016/j.eist.2017.04.002

Prajuly, K., Wenzel, H. (2017). “Potential for circular economy in household WEEE management,” *Journal of Cleaner Production,* 151:272-285. https://doi.org/10.1016/j.jclepro.2017.03.045

Potdar, A., Rogers, J. (2010). “Methodology to forecast product returns for the consumer electronics industry,” *PICMET 2010 Technology Management for Global Economic Growth.*

UNEP (2017). *Compendium of Technologies for the Recovery of Materials from WEEE or E-Waste.* United Nations Environment Programme.

WRAP (2011). *Summary Report: Realising the Reuse Value of Household WEEE.* Waste Resources Action Plan.

8.4 Barrier Alleviation & Uptake Modeling

Bocken, N., de Pauw, I., Bakker, C., van der Grinten, B. (2016). “Product design and business model strategies for a circular economy,” *Journal of Industrial and Production Engineering,* 33(5):308-320. https://doi.org/10.1080/21681015.2016.1172124

Bovea, M., Ibáñez-Forés, V., Prez-Belis, V., Quemades-Beltrán, P. (2016). “Potential reuse of small hpusehold waste electrical and electronic equipment: Methodology and case study,” *Waste Management,* 53:204-217. http://dx.doi.org/10.1016/j.wasman.2016.03.038

Kalmykova, Y., Sadagopan, M., & Rosado, L. (2018). “Circular economy–From review of theories and practices to development of implementation tools,” *Resources, conservation and recycling*, 135:190-201. https://doi.org/10.1016/j.resconrec.2017.10.034

Lewandowski, M. (2016). “Designing the Business Models for Circular Economy—Towards the Conceptual Framework,” *Sustainability,* 8(1). https://doi.org/10.3390/su8010043

Östlin, J., Sundin, E., Björkman, M. (2009). “Product life-cycle implications for remanufacturing strategies,” *Journal of Cleaner Production,* 17:999-1009. doi:10.1016/j.jclepro.2009.02.021

PSF (2012). *Priority Products Part 3: Reducing the environmental and cost impacts of electrical products.* Product Sustainability Forum report for Waste Resources Action Plan.

Prajuly, K., Wenzel, H. (2017). “Potential for circular economy in household WEEE management,” *Journal of Cleaner Production,* 151:272-285. https://doi.org/10.1016/j.jclepro.2017.03.045

Urbinati, A., Chiaroni, D., & Chiesa, V. (2017). “Towards a new taxonomy of circular economy business models,” *Journal of Cleaner Production*, 168:487-498. https://doi.org/10.1016/j.jclepro.2017.09.047

Zlamparet, G. I., Ijomah, W., Miao, Y., Awasthi, A. K., Zeng, X., & Li, J. (2017). “Remanufacturing strategies: A solution for WEEE problem,” *Journal of Cleaner Production*, 149:126-136. https://doi.org/10.1016/j.jclepro.2017.02.004

8.5 Estimation of Economic & Environmental Impacts

Ardente, F., & Mathieux, F. (2012b). *Integration of resource efficiency and waste management criteria in European product policies – second phase. Report n2: Application of the project’s methods to three product groups (final)*. https://doi.org/10.2788/75910

Bradley, R., Jawahir, I. S., Badurdeen, F., & Rouch, K. (2018). “A total life cycle cost model (TLCCM) for the circular economy and its application to post-recovery resource allocation,” *Resources, Conservation and Recycling*, 135:141-149.

Cooper, D.R., Gutkowski, T.G. (2015). “The Environmental Impacts of Reuse: A Review,” *Journal of Industrial Ecology,* 21(1):38-56. DOI: 10.1111/jiec.12388

Goodship, V., Stevels, A., & Huisman, J. (2019). “The e-waste development cycle, part II—impact assessment of collection and treatment,” Chapter 3 in *Waste electrical and electronic equipment (WEEE) handbook*. Woodhead Publishing. ISBN 9780857090898

Kasulaitis, B. V., Babbitt, C. W., & Krock, A. K. (2019). “Dematerialization and the circular economy: Comparing strategies to reduce material impacts of the consumer electronic product ecosystem,” *Journal of Industrial Ecology*, 23(1):119-132. https://doi.org/10.1111/jiec.12756

Park, J., Sarkis, J., & Wu, Z. (2010). “Creating integrated business and environmental value within the context of China’s circular economy and ecological modernization,” *Journal of Cleaner Production*, 18(15):1494-1501. https://doi.org/10.1016/j.jclepro.2010.06.001

Pauliuk, Stefan, Tomer Fishman, Niko Heeren, Peter Berrill, Qingshi Tu, Paul Wolfram, and Edgar G. Hertwich. n.d. “Linking Service Provision to Material Cycles: A New Framework for Studying the Resource Efficiency–Climate Change (RECC) Nexus.” *Journal of Industrial Ecology* https://doi.org/10.1111/jiec.13023

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Wood, Richard, and Edgar G. Hertwich. 2013. “Economic Modelling and Indicators in Life Cycle Sustainability Assessment.” *The International Journal of Life Cycle Assessment* 18 (9): 1710–21. https://doi.org/10.1007/s11367-012-0463-2

see papers listed in the comments above

8.6 Policy Recommendations

Ardente, F., Talens Peiró, L., Mathieux, F., & Polverini, D. (2018). Accounting for the environmental benefits of remanufactured products: Method and application. *Journal of Cleaner Production*, *198*, 1545–1558. https://doi.org/10.1016/J.JCLEPRO.2018.07.012

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Goodship, V., Stevels, A., & Huisman, J. (2019). “Implementation road map and conditions for success,” Chapter 4 in *Waste electrical and electronic equipment (WEEE) handbook*. Woodhead Publishing. ISBN 9780857090898

Taranic, I., Behrens, A., & Topi, C. (2016). “Understanding the circular economy in Europe, from resource efficiency to sharing platforms: The CEPS framework,” *CEPS Special Reports*, (143). https://ssrn.com/abstract=2859414

Webster, S., & Mitra, S. (2007). “Competitive strategy in remanufacturing and the impact of take-back laws,” *Journal of Operations Management*, 25(6): 1123-1140. https://doi.org/10.1016/j.jom.2007.01.014

International Resource Panel – Meeting Document

Doc: IRP/31/09
Date: 05.02.2024
Status: For approval

Title: Terms of Reference: "Decarbonizing Global Cities with Environment, Health and Biodiversity Co-Benefits: A Land-Use Linked Multi-Sector Provisioning Systems Approach"
At the 30th IRP meeting, Members welcomed the proposal to develop a scientific assessment on 'Toward Zero-Carbon Urban Regions with Climate-Readiness, Health, Wellbeing, and Equity Co-benefits', and provided oral and written feedback on the Concept Note submitted. Lead Authors were invited to submit Terms of Reference by end Q4 2023.
References: *Policies and Procedures of the International Resource Panel* **IV.3 Rapid Study and Assessment** 82. Scoping exercise and Work Programme. A Rapid Study and Assessment may be proposed at any moment by an IRP member. The Secretariat may organize a scoping meeting if deemed necessary for the development of the ToRs. 83. If proposed during the strategic planning exercise, the elements described in paragraph 73(a) must be included in the Work Programme prior to the development of the ToRs. The Panel provides input and recommendations while the Steering Committee approves the Work Programme as per paragraph 73(a). 84. Terms of reference. Panel members, with the support of the Secretariat, prepare and submit to the Panel and Steering Committee the ToRs of the Rapid Study and Assessment in accordance with paragraph 73(b) of these procedures. Working Group meetings may be organized as needed for the preparation of the ToRs and draft. 85. Preparation and review of draft. A Draft of the Rapid Study and Assessment is reviewed by the Panel and Steering Committee as per the procedure established in paragraph 73(c) of these procedures. 86. External Expert Review Process. The approved Draft of the Rapid Study and Assessment is reviewed by Expert Reviewers as per paragraph 73(d) of these procedures. Expert Reviewers will have up to one month to review and provide comments to the Draft of the Rapid Study and Assessment. 87. Preparation and review of final draft. After External Expert Review, the Steering Committee provides input and recommendations to the final draft and the Panel reviews and approves for publication through an expedite process.

Terms of Reference

Decarbonizing Global Cities with Environment, Health and Biodiversity Co-Benefits: A Land-Use Linked Multi-Sector Provisioning Systems Approach

Date: February 2, 2024

Drafted by: Dr. Anu Ramaswami, Dr. Edgar Hertwich

1. Complex Urban Challenges and Urgency to Act

Urban areas contribute over 70% of global greenhouse gas (GHG) emissions (Intergovernmental Panel on Climate Change (IPCC), 2023). Urban areas are also where more than two-thirds of the world's population will be living by the year 2050, and where the concentration of large populations exposed to high levels of air pollution as well as climate extremes, is already contributing to more than 7 million premature deaths annually worldwide (Ramaswami et al., 2023). Extreme heat associated with climate change, and exacerbated by urban form, is a particularly significant climate risk affecting much of the global south, and particularly those nations undergoing massive new urbanization - such as India and China, urbanizing Southeast Asian nations, and much of Africa, particularly Nigeria which is anticipated to see the largest increase in urban population after China and India (UN, 2018). Such increases in urban heat are also projected to substantially increase demand for energy as cities in these regions grow – increasing GHG emissions and impacting all the SDGs (Khosla et al., 2021).

As massive urbanization and infrastructure investments are made in the coming decades to house more than 2.2 billion new urbanites in Asia and Africa, there is an urgency for transformative design of cities and metropolitan regions through systems frameworks that consider multiple sectors, multiple strategies and multiple outcomes - decarbonization, biodiversity preservation, pollution mitigation and associated health co-benefits.

Developing next-generation systems modelling to support the development of zero carbon cities with environment, health and biodiversity co-benefits is the purpose of our report.

Such a systems integration of sectors, pathways and outcomes is a hallmark of IRP's approach and is necessary to advance multiple SDGs. While the GRO reports have focused at national scales, this report proposes to demonstrate bottom-up integrated modelling toward decarbonized cities with environment, health and biodiversity co-benefits through deep study of a cohort of global cities drawn from nations with large urbanizing populations (India, China, ASEAN Nations and Sub-Saharan Africa (likely Nigeria)).

2. Relation with the IRP Work Programme

The proposed study is part of the High Impact Priority Area HIPA2 – Sustainable Resource Management for effective action on climate change, biodiversity, and pollution. It is a merger of two proposals that were developed for and are mentioned in the IRP Work Programme for 2022-2025. The work programme emphasizes the value of a value chain perspective and a provisioning system perspective, both of which are an integral part of this work. In addition, it mentions the relevance for reaching the Paris climate target and UNCBD biodiversity target. These targets are taken into account when designing and evaluating the proposed scenarios. Further, the work is also relevant for HIPA3. It investigates the effect of urbanization in emerging economies, which is the primary mechanism by which prosperity is increased in low- and middle-income regions. The investigates the provision of services, such as shelter and mobility, both in terms of quantity and quality, seeking to reduce the trade-off between human well-being and the protection of the environment.

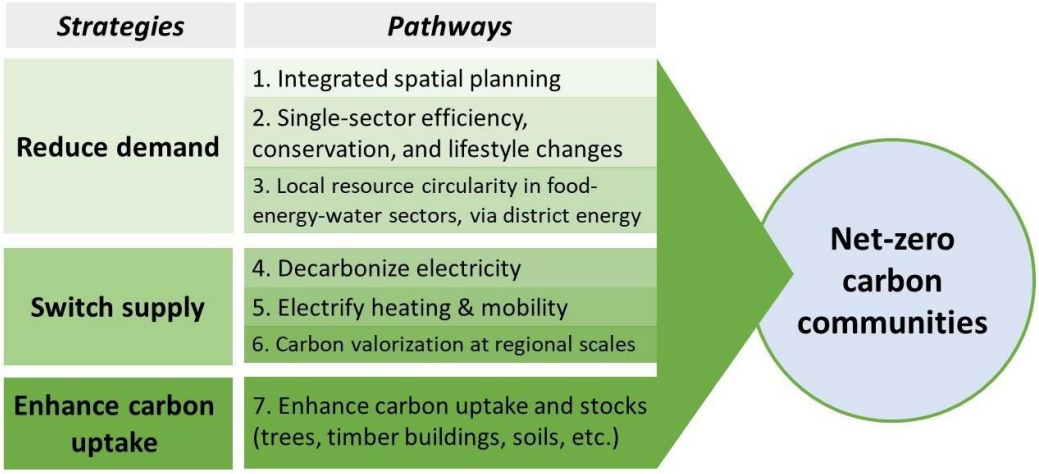
The work will be consistent with the provisioning systems focus of the GRO report (IRP, 2024, 2019). It offers a deep dive into uniquely urban potentials that can be important for the future scenario development in subsequent GRO reports. It builds upon the successful The Weight of Cities report (IRP, 2018) and Resource Efficiency and Climate Change (IRP, 2020)

3. Existing Knowledge Base on Urban Transitions

Urban decarbonization pathways: More than 1,000 cities have committed to achieving net-zero GHG emissions by 2050, in efforts to align with national and global net-zero goals aimed at limiting global warming to 1.5 degrees Celsius. Henceforth, we refer to net-zero GHGs as zero-carbon goal, for brevity. Cities and urban areas, and particularly urban infrastructure and urban form, will play a significant role in decarbonization (Intergovernmental Panel on Climate Change (IPCC), 2023). Conceptual frameworks to achieve urban zero-carbon emissions have been developed (e.g., see Figure 1 (Seto et al., 2021)) combining a cascade of pathways including: 1) Reducing resource demand through spatial-efficiency, single-sector and cross-

sector efficiency, e.g., leveraging the food-energy-water-wastewater and lifestyle changes; 2) Transforming supply through switching to electric heating and mobility accompanied by decarbonized electricity and industrial fuels; 3) Carbon sequestration in metropolitan buildings, trees/green infrastructure and soil. (See Figure 1). The pathways in Fig 1 encompass land-use linkages of 7 key provisioning systems in cities – energy, mobility, construction, water, waste management, food and green infrastructure systems. These seven provisioning systems collectively and globally contribute over 94% of global GHG emissions, more than 96% of water withdrawals (Ramaswami et al., 2023) and in excess of 80% of minerals and metals extraction (IRP, 2019). Thus, a systems perspective encompassing land use linkages, within and outside city boundaries, of the seven key provisioning systems is needed to chart pathways toward zero-carbon cities integrating all the pathways.

Fig 1: A conceptual framework toward zero-carbon cities integrating multiple pathways (adapted from (Seto et al., 2021); (Ramaswami et al., 2024))



Co-benefits/Nexus of Urban Zero-Carbon Transitions: There can be synergies as well as trade-offs between urban zero carbon transitions and natural resource use (land, water, bioresources, minerals/metals), environmental pollution, biodiversity and related impacts on human health. While the linkages between energy transitions and air pollution are relatively well-studied, a recent review (Ramaswami et al., 2023) finds the nexus between urban zero-carbon transitions and broader environmental impacts – e.g., on land, water, biodiversity – are not well quantified, particularly as impacts can transcend urban boundaries through supply chains, well represented in the foot printing approach adopted in IRP's GRO. Likewise the nexus interactions between decarbonization pathways and climate-adaptive co-benefits are mostly understood qualitatively, summarized recently in IPCC (Intergovernmental Panel on Climate Change (IPCC), 2023), but unquantified. The design of cities to simultaneously decarbonize and also be resilient to climate risks is a frontier research topic. This is also emerging at the forefront of strategic infrastructure planning in several global cities – for example, Chennai, India has launched a 2-year study to develop her 2050 plan aiming to address climate risks and decarbonization.

Need for Integrative Multi-Sector Multi-Strategy Modeling: Recent research has shown that resource efficiency strategies including space-efficient urban forms (Creutzig et al., 2016), demand reduction strategies such as ride-sharing (Fagnant and Kockelman, 2018), novel construction materials such as mass timber and other local construction materials (Churkina et al., 2020), novel white paints (Feng et al., 2021), resource circularity leveraging the food-energy-water nexus (Hodge et al., 2016), multi-resource advanced district energy solution (Lund et al., 2021), and nature-based solutions (green infrastructure) (Nowak et al., 2013; Teo et al., 2021). These strategies all have important roles to play in resource efficiency and decarbonization with potential environmental, biodiversity and climate co-benefits. However, while each of these strategies has been assessed individually in the above referenced papers, integrative quantitative systems-based models combining these strategies across sectors, leveraging interactions with land use, and quantifying multiple SDG linkages to environment, biodiversity and health, are lacking. Furthermore, real world bottom-up studies are also needed to explore mechanisms for governance and financing of these diverse strategies (e.g., green bonds, carbon credits, etc.).

4. PURPOSE AND OBJECTIVES

To address the above knowledge needs, the primary goal of this work is to develop partnerships with a cohort of around 7 cities and metro regions drawn from nations with large urbanizing populations, to advance a bottom-up data-driven transboundary multi-sector, multi-strategy decarbonization model for cities, with assessment of co-benefits to resource use (water, land), biodiversity, pollution, and health. We propose to focus on cities and metropolitan regions in India, China, ASEAN, Sub-Saharan Africa that are already working on strategic future planning of sustainable urban transitions, and where

substantial bottom-up data are already being gathered, often in collaboration with researchers, UNEP Cites Unit or the World Bank or with their national governments.

We will also explore the nexus between design of zero carbon cities and local strategies for climate risk mitigation, focusing on extreme heat events, given substantial heat stress is projected to impact much of the very nations where massive new urbanization is unfolding. Given budget limitations, this will be accomplished qualitatively across a network of around 7 cities from the Global South, and likely quantitatively in a smaller subset.

We will identify different emerging financing models to implement urban land use and infrastructure design for the multiple goals, comparing financing approaches across the case studies and drawing from emerging green financing frameworks.

In a concluding workshop, we will explore mechanisms for scaling-up urban land use and infrastructure design for decarbonization with multiple co-benefits across all urban areas in the nation to connect with GRO's national models to contribute to the next GRO report.

Specific Objectives are as follows:

- **Develop partnerships for knowledge co-production** between the IRP research team and policymakers in the selected urban regions through periodic workshops (online, after an initial in-person launch). We propose to partner with urban regions already engaged in strategic urban futures planning with collaboration with UNEP Cities, UN Habitat, World Bank or national pilot programs.

- **Establish current GHG footprints and future projections based on** population, land use and different scenarios consistent larger scale shared socioeconomic pathways (SSP).

- **Explore and quantify diverse pathways** towards zero carbon urban systems in different global regions leveraging the pathways framework in Figure 1. Specifically, the report would focus on uniquely urban opportunities for resource efficiency, such as land use planning, shared mobility and work-spaces, novel construction technologies, local energy innovations, urban forestry, circular economy, co-location driven resource circularity at the food-energy-water-waste nexus, and others.

- **Quantify co-benefits of zero-carbon pathways** to resource use, air pollution, biodiversity and health. Qualitatively assess the nexus of zero-carbon and climate risk mitigation design strategies through workshops identifying local climate-resilience solution; quantitative analysis/modelling of climate risk mitigation will require a larger budget and may be undertaken only for a few cohort cities.

- **Compare financing models** emerging in the different cohort urban regions to develop synthesis around metrics to support green financing and carbon financing.

- **Stimulate and evaluate policy-oriented learning** that occurs through the processes of co-producing pathways with a cohort of seven urban regions drawn from different continents.

5. POLICY RELEVANT QUESTIONS

- How are cities imaging their futures in 2050?

- Can urban metropolitan achieve near zero-carbon provisioning systems through a combination of demand side interventions including spatial planning, behavioural nudging, local energy innovations, novel construction technologies, resource circularity at the food-energy-water-waste nexus, and nature based solutions?
    - What are dominant urban zero-carbon pathways in different world regions?
    - How can urban interventions reduce demand while providing services and contribute to overall societal decarbonization.

- What is the role of urban-rural interactions in decarbonizing provisioning systems?

- What are the co-benefits of urban zero-carbon transitions – e.g. to resources, environment with attention to air pollution, public health, biodiversity, and climate-impacts?

- How can cities/metro regions practically finance the multiple pathways toward zero-carbon, resource efficient, healthy cities, navigating different scales of action (city, national), and the different impacts to resources, health,

climate readiness?

- How is policy-oriented learning accelerated during cohort-based knowledge co-production, including learning across cities and learning between multiple stakeholders within cities?

6. AVAILABLE EXPERTISE

The co-lead authors are well positioned to undertake a thematic focus on urban zero-carbon transitions. Next-generation multi-sector, multi-strategy zero-carbon models are emerging that enable consideration of multiple pathways, sectors and outcomes. For example, IRP member, Anu Ramaswami, has developed urban zero-carbon pathway models across multiple sectors through co-production with the Twin Cities Metropolitan region, USA (Ramaswami et al., 2024). She has worked on GHG footprinting and air pollution in several cities in India and China, and has developed a first All-India GHG emissions database for all 630+ urban districts of India (Tong et al., 2018; 2021). She has collaborated with UNEP to regionalize IRP's Weight of Cities report to the ASEAN region (UNEP, 2018), More recently, she has also developed a framework and large literature review to assess the nexus between decarbonization pathways, and environment, health, climate resilience (Ramaswami et al., 2023). Ramaswami brings many years of knowledge co-production experience with cities. She is also developing a bottom-up health risk model covering diverse risk factors in cities, including infrastructure deficits, environmental pollution, climate extremes and behavioural/lifestyle risks. IRP member, Edgar Hertwich, and his team have developed building archetypes and analysed options for resource efficiency in Argentina, Indonesia, Mexico, the Middle East, and Nigeria (Akin et al., 2023; Jatkar et al., 2024a, 2024b, 2024c), as well as the global road network (Rousseau et al., 2022). We propose a key collaborator - Dan Hoornweg, formerly lead urban specialist at the World Bank who is working on future socioeconomic projections and sustainable design for several African cities (Luo et al., 2020).

IRP Expertise and Scale of Impact: By focusing on the physical provisioning systems that provide energy, mobility, construction materials, water, waste and wastewater management, food/agriculture and green spaces, the authors aim to propose a practical path to zero-carbon, particularly for the 2.2 billion new urban-dwellers anticipated in Asia and Africa from 2025-2050. Authors intend to use a pathways framework anchored upon the provisioning systems which aligns well with IRP's GRO, enabling urban pathways studies here to connect with national trajectories.

Selection of 7 Global Cities/Metro Regions in Emerging Economies: We plan to study larger metropolitan regions rather than only central cities to enable study of diverse strategies in central cities as well as outlying urbanizing communities at the urban-rural edge, where most new urban expansion is occurring. We propose to focus on cities and metropolitan regions in India, China, ASEAN, Sub-Saharan Africa that are already working on strategic future planning of sustainable urban transitions, and where substantial bottom-up data are already being gathered, often in collaboration with IRP researchers, UNEP Cities Unit or the World Bank or with their national governments. The Table below shows the activities and the city partnerships underway among Ramaswami, Hertwich and proposed collaborators. Additional partnerships are also likely among panel members as noted below (and the list can be expanded). Final selection of the 7 metro regions will be based on: countries of interest (China, India, ASEAN, African nations with focus on Sub Saharan Africa); existing strategic planning efforts at these cities/metros ideally with UNEP/World Bank/GEF; availability of substantial bottom-up data; active linkages with IRP researchers; and consideration of diverse climate risks, focusing on heat and humidity. Thus, we may select in each nation or world region cities in hot-humid coastal areas and hot-dry inland cities.

Metro regions	**Expertise and partnerships**
India	Report lead, Dr. Ramaswami is presently developing an MOU to partner with the Chennai Metropolitan Development Authority (hot, humid, coastal metro already working with The World Bank and C-40 Cities to chart pathways to decarbonize with climate adaptation). She is also in discussion with other cities/urban regions in India (e.g., Jaipur, Rajasthan, and Surat, Gujarat), the latter identified as a pilot city by India's NITI Aayog (personal communications). Ramaswami has worked extensively with cities in India, in partnership with ICLEI South Asia. She has also developed a database of all 630+ Urban Districts of India (Tong et al., 2018).
Sub-Saharan Africa	Dr. Hoornweg is presently working with a several different cities in Africa, some in partnership with The World Bank. Princton University also has a long-standing relationship taking students to work on climate adaptation planning in Accra, Ghana and Adis Ababa.
Middle East	Report co-lead, Dr. Hertwich's team has experience with resource efficiency in residential buildings and would be interested to expand this to a city scale in Turkey. Potential cities: Ankara, Antalia, Isfahan, or similar.

ASEAN nations	Dr. Ramaswami previously completed a regional report on the ASEAN and has broad regional context. Dr. Hertwich has worked previously on Nusantra, new capital city of Indonesia. Panel member, Anthony Chiu, as well as Panel member, Heinz Schandl, and collaborators at CSIRO have interest in working with ASEAN
China	Panel Member, Bing Zhu, along with collaborator, KK Tong, who bring deep expertise in the larger Shanghai Metro region.
In addition, we will also model these transitions in more developed nations through ongoing work. Specifically, with the Twin Cities, Minnesota in the US, where Ramaswami has piloted the framework (in review at Nature Sustainability). We have commitment to replicate the approach in Barcelona from Gara Vilalba who also works closely with metropolitan agencies. The focus on developed nations is planned to be limited enabling focus on cities in emerging and less-developed economies undergoing urbanization.	

7. SCOPE

1. **Conceptual framework:** The report will build upon a conceptual framework developed in a recent publication (Seto et al., 2021). See Fig 1.

2. **Focus on provisioning systems**, i.e., energy, mobility, buildings, water, waste, and green spaces, since they contribute >88% of greenhouse gas emissions, >90% of water withdrawals, and ~20 million premature deaths worldwide (Ramaswami, 2020).

   The scope of the report does not extend to studying decarbonization of the food system per se, but the report will explore intersections between food-energy-water-waste systems in terms of nutrient recycling to farms located in metro regions, waste to energy, etc.

3. **Operational framework:** The report will draw upon an operational framework that develops a land-use linked multi-sector urban metabolism model that operationalizes the above conceptual framework, and has been tested in a few US cities (paper in review, (Ramaswami et al., 2024)).

4. **Data framework:** The work will leverage data already being gathered by lead authors, associated panel members, partnership cities and collaborating scientists.

8. WORK PLAN AND OUTLINE

It is proposed that the report will study **5-7 urban regions across the world**, and engage with ICLEI – a network of more than 2000 global cities to disseminate our findings more broadly. Urban regions are large metropolitan areas allow study of central cities, suburbs and emerging rural edge communities. The selection criteria for the cohort of 7 propose Metro Regions is presented in Section 6.

Phase I: Developing Partnerships ad Common Frameworks (0 to 6 months)

- Identification of local partners and stakeholders, and final agreement on which cities and metro regions to focus on. **Opening in-person workshop with all partner researchers and cities/metros.** (0- 3 months)
- Agreement on and documentation of methods used across participating researchers and cities. Discussion of creating a centralized versus federated data hub as needed. (during the workshop and after)
- Literature review and synthesis presentation at Workshop. Identification of activity leads and writing leads for associated Chapters and papers. Some preliminary distribution of leadership of activities is below. (0 – 6 months)

Phase II: Develop baseline data and 2050 projections under various scenarios, with practitioner input (3 to 9 months)

- Gather relevant baseline data at federated sites.
- Model 2050 futures using various scenarios of population, inequality, provisioning systems, etc., broadly consistent with the GRO report, but at the urban scale.
  - Ramaswami will lead methods for bottom-up generation of 2050 scenarios;
  - Herwich will develop methods for top-down approaches and scaling up to GRO models.
  - Site specific leaders will lead reports/papers on their sites in the different nations.
- Develop baseline 2023 and “business as usual” future 2050 community-wide infrastructure GHG footprints for the

provisioning systems at metropolitan regional scales, consistent with the Global Protocol for Cities Scope1+2+3 accounting, using spreadsheet tools developed in Ramaswami's group and shared with several US cities.

- **Online workshop with the city cohort** to share models and gather feedback on scenarios. A co-learning survey will also be piloted to assess how both researchers and policymakers have learned from each other (Ramaswami and Hajer)

Phase III: Model urban land use and infrastructure strategies for decarbonization with resource, pollution mitigation, health and biodiversity linkages (6 to 18 months)

- Develop a zero-carbon model for the 7 global city cohort consistent with Figure 1, toward zero carbon goals (Ramaswami will lead in collaboration with Hertwich, Zhu, Tong and all other city research partners, building upon a simplified interactive spreadsheet model co-produced with the Twin Cities (Ramaswami et al., 2024)).
- Quantify resource-, land, biodiversity and air pollution benefits in approaches consistent with GRO models (Hertwich will lead in collaboration with Hellweg, Schandl, Ramaswami, and others)
- Develop a baseline health risk assessment model for to demonstrate the current health risks from infrastructure, environment and climate risks, and potential health risk reduction from zero-carbon design. This effort will be led by Ramaswami, using a spreadsheet model recently developed, drawing upon the Global Burden of Disease Methodology (manuscript in review; visualization tool can be shared live at the IRP session).
- **Interim online workshop at Year 1 mark with City-Cohorts** to share preliminary results and to survey local strategies for climate adaptation in conjunction with decarbonization. We will also use this workshop to understand emerging mechanisms for financing the different strategies in the case city regions.

Phase IV: Financing Multi-Objective Urban Transitions, Disseminating Results (12 to 18 months)

- Assess different models for financing the different strategies, comparing approaches to finance demand reduction, new infrastructure for carbon mitigation, nature based solutions and adaptation. We estimate that Ramaswami, Hoornweg, Hajer, Ali would be engaged in this effort.

Phase V: Finalize report and disseminate findings to larger networks of cities (18 to 24 months)

- Organize a closing workshop with a larger network of cities convened by IRP with UNEP, World Bank, ICLEI and others to disseminate the findings of the report (or attend annual conferences of these groups to disseminate)

9. REPORT OUTLINE

The report would be organized as follows:

Chapter 1: Conceptual framing and Policy Landscape of zero-carbon, resource efficient, healthy cities

Chapter 2: Baseline and Future 2050 Scenarios for Population, infrastructure and inequality in urban systems in 7 cohort Metro Regions (Summary of empirical results)

Chapter 3: Modeling baseline and future Scenario projections of various footprints of urban provisioning systems (land, GHGs, water, pollution, biodiversity impacts and health impacts)

Chapter 4: Modeling pathways toward zero-carbon cities (Fig 1), under different future scenarios. National grid transition from larger scale studies (Deep Decarbonization Pathway reports) will be used as a background.

Chapter 5: Quantifying benefits/linkages to resource efficiency, pollution, biodiversity, health and potential nexus linkages to climate-risk mitigation (Summary of modelling results and stakeholder interactions).

Chapter 6: Comparing actors engaged and mechanisms for financing urban transitions in the cohort, and broadly.

Chapter 7: A summary of learnings across cities and among researchers and practitioners

Appendix 1: Detail on framework and methodology

Appendix 2: Report for Individual Cities/Metro Regions

10. VALUE-ADDED CONTRIBUTIONS OF THIS REPORT

Knowledge and Modelling Gaps: Presently, there are no multi-sector bottom-up models for cities and urban metro regions to develop pathways to decarbonization with multiple co-benefits. Current decarbonization modelling can be described at three scales as below:

- At the global scale, IPCC (2023)(Intergovernmental Panel on Climate Change (IPCC), 2023) has assessed the decarbonization gap across aggregate urban areas in different nations, it does not address actual trajectories and fine-spatial scale opportunities within individual urban regions.
- At the national scale, current national macro-energy system based zero-carbon models, such as Net Zero America, are largely supply side technology focused on grid transition and more expensive Carbon capture utilization and storage, or on green hydrogen. They do not incorporate fine scale multi-sector urban-specific pathways described above that can transform the nature of urban demand.
- At the city-scale, most decarbonization models focus primarily only on buildings' energy use, mobility and waste, and only on single outcome of carbon mitigation. However, a focus on land-use and the seven provisioning systems is important to align urban actions with larger scale decarbonization models and is a critical gap for cities.

Lastly, there are no systematic models to link decarbonization strategies with multiple co-benefits to environment, health and biodiversity.

Value-add: From a policy perspective, we will streamline a systems' approach for cities to advance the following tools:

- A baseline quantification of water, land, GHG, and materials footprint of the seven key provisioning systems in urban areas consistent with the GRO approach
- A systematic pathways framework for urban areas to decarbonize focusing on the multiple strategies illustrated in Figure 1, enabling cities to understand the impact of actions in their purview compared to utility-scale actions towards a zero-carbon grid and national policies relating to green hydrogen for industrial decarbonization
- A cost assessment to demonstrate the benefit of acting at the urban scale, which can complement national grid decarbonization efforts.
- Assessment of interactions between decarbonization strategies and climate-adaptive strategies, and their potential for environment, health, and biodiversity co-benefits
- Practical guidance on how to plan land-use and urban infrastructure today to support future decarbonization with co-benefits

11. AUDIENCE, OUTREACH, AND IMPACT

- Cities and urban metropolitan government agencies that plan land-use and urban infrastructure
- Multi-city networks like ICLEI
- National urban planning departments and national infrastructure planning departments
- Architects and private-sector firms

12. PROPOSED LEAD AUTHORS AND CONTRIBUTING AUTHORS

Lead: Anu Ramaswami, Princeton University; Edgar Hertwich, Norwegian University of Science and Technology

with Heinz Schandl, Stefanie Hellweg, Bing Zhu, Maarten Hajer, Dan Hoornweg, Ester van der Voet, Anders Wijkman, Eeva Primmer, Saleem Ali, Stefan Pauliuk, Kangkang Tong, and others

Potential to disseminate our findings to a large network of global cities through collaboration with UNEP, UN Habitat, World Bank, ICLEI.

13. KEY RESOURCES

- BuildME building archetype assessment model, https://github.com/nheeren/BuildME
- ODYM-RECC model and database. https://github.com/IndEcol/RECC-ODYM
- IRP (2018). The Weight of Cities: Resource Requirements of Future Urbanization. Swilling, M., Hajer, M., Baynes, T., Bergesen, J., Labbé, F., Musango, J.K., Ramaswami, A., Robinson, B., Salat, S., Suh, S., Currie, P., Fang, A., Hanson, A. Kruit, K., Reiner, M., Smit, S., Tabory, S. A Report by the International Resource Panel. United Nations Environment Programme, Nairobi, Kenya. Available at: http://www.resourcepanel.org/reports/weight-cities

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- Ramaswami, A., Tong, K., Pandey, B., Hawkins, J., Chen, J., Kockelman, K., Leon, M., & Gumus-Dawes, B. (2024 – in review). Toward Zero-Carbon Resource-Circular Cities and Metropolitan Regions, In review at Nature Sustainability. (and, associated spreadsheet tool: Zero Carbon Calculator for Cities/Regions)

- Tong, K., Nagpure, A. S., & Ramaswami, A. (2021). All urban areas' energy use data across 640 districts in India for the year 2011. Scientific Data, 8(1), Article 1. https://doi.org/10.1038/s41597-021-00853-7 [All India Urban Data]

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- Seto, K., Churkina, G., Newman, P.W.G., Qin, B., & Ramaswami, A. (2021). From Low- to Net-Zero Carbon Cities: The Next Global Agenda. Annual Review of Environment and Resources, 46, doi: 10.1146/annurev-environ-050120-113117.

14. BUDGET

Ramaswami, Princeton University: Overall coordination of the project across the 7 case study cities. Lead of the multi-sector multi-strategy zero-carbon modelling approach and bottom-up assessment of health co-benefits and climate adaptation nexus. Mainstreaming a spread sheet based model for GHG footprinting, zero-carbon pathways modelling, and an associated spreadsheet based model for health risk assessment. PU Librarian can support data hosting as needed. [USD 150,000 for 2 half time post docs for 12 months each, and a part time staff trained in co-production and report writing] Princeton University USD 150,000

Hertwich,NTNU Lead modelling of building stock using available models where data are sparse, coordinating top-down assessments of future SSP, developing quantitative modelling of land use and biodiversity impacts, other drafting support, etc. NTNU USD 100,000

Workshop Costs: USD 50,000

Report Preparation Cost at UNEP: USD 50,000

Total: USD 350,000

This assumes that the cohort of cities already has resources for data-gathering, etc. which will be the basis of selection. We have not budgeted for Dr. Hoornweg yet as cities are not yet determined.

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Terms of Reference

for the Study proposed to IRP on

"Socio-economic implications of enhancing resource efficiency and promoting circular economy"

(HIPA 3.3)

Table of Contents

I. Background and Relationship to IRP's Programme

Background

Use of global material resources – biomass, fossil fuels, metals and non-metallic minerals – reached some 90 billion tonnes in 2017, i.e. more than three times the amount used in 1970, according to an estimate of the International Resource Panel (Global Resource Outlook, 2019). If current trends continue, by 2050 resource use is expected to go up further to 186 billion tonnes. The growing population, primarily in Asia and Africa, and high per capita material footprints, much of it in the industrialized Europe, Americas and Australia are among the key drivers of the massive and growing resource use over the past century. (UNEP, 2017) Global production and consumption systems are reaching an unprecedented state of unsustainability, breaching the safe operating spaces of planetary boundaries.

In particular, the material intensity of the world economy has been rising rapidly over the past several decades. Massive increases in construction, infrastructure and transport facilities have created ever-greater demands for natural resources. Evolving consumption patterns have led to a huge demand for domestic appliances, recreational facilities and equipment which in turn need more and more metals and plastics. Although changes are taking place in public attitudes towards reducing resource use and generating wastes, much remains to be done. Much of the early emphasis has been through better design, e.g. by extending the life of products, improving their durability and downsizing or miniaturizing them, as well as recycling products and their parts. More recently attempts are being made to share more products and shared economic activities, the impacts are yet to reach a meaningful scale. At the same time, industrial and other production has been shifting from countries with high material efficiency to countries that have yet to achieve such efficiencies, resulting in the overall increase of material intensity in the global economy. All these factors have resulted in growing environmental pressures - in total, on a per capita basis and for a unit of economic activity. (UNEP, 2016)

Material consumption varies across the world and is fairly unequal among and within nations and socio-economic classes. High-income countries currently consume more than 10 times higher quantities of materials per person than low-income countries. The 1.2 billion poorest people account for 1 per cent of the world's consumption, while the billion richest consume 72 per cent of the world's resources. (UNE, 2018) Disparities in resource distribution and use within and across countries have impeded efforts to reorient development patterns towards greater sustainability. They are major causes of resource scarcity and of threats to resource security, which eventually has led to problems such as poverty, biodiversity loss, climate change, military conflict and social breakdowns in various parts of the world.

The degree of impoverishment and marginalization also varies substantially within and across countries. 736 million people live in extreme poverty, surviving on less than $1.90 a day. (World Bank, 2015) Although the income of the lowest earning half of world's population has grown during the last 30 years, the inequality of income distribution has grown much faster, as the richest 1% has captured most of this growth (Alvaredo et al., 2018). Still, the absolute number of undernourished people, that is those facing chronic food deprivation, has increased to nearly 821 million in 2017, from around 804 million in 2016. (FAO, 2017) Further, 663 million people – one in 10 – still drink water from unprotected sources. Of these, almost half live in sub-Saharan Africa, eight in ten live in rural areas, and most of them are among the poorest. (WHO, 2015) The SDGs can only be achieved if the basic needs of all are fulfilled and the benefits from resource efficiency and circular economy practices allow greater access and affordability of resources to the poorest in society.

Resource efficiency and circular economy actions and measures alone cannot address the distributional needs that are essential to achieve SDGs especially in enabling the marginalized to achieve acceptable standards of well-being. The international negotiations that formulated the SDGs clearly highlighted that development strategies have to be more human in scale, less wasteful of resources and directly responsive to the basic needs of people. Strategies to attain sustainable development must therefore ensure that resource efficiency measures also support eradication of

poverty, fulfilment of basic needs and regeneration of the environment. One of the preconditions for this is that resource efficiency measures do not exacerbate the large gap that persists between the affluent and the poor, nationally or globally. For the world to achieve its goals of poverty eradication (SDG 1) and basic needs for all (SDG 2, 3, 4, 6, 7), it will have to design economic systems and strategies (SDG 8, 9, 12) that can enable this to happen within the planetary boundaries (Paris Agreement, SDG 13, 14, 15). The possibility for such sustainable development is undermined if the economic and social disparities in a society are large (SDG 5, 10) For instance in case of energy demands, the rich over utilises resources and the very poor have to rely for their daily existence on fragile access to resources, often depleting resource producing ecosystems producing food and duel beyond the regeneration

Growing material intensity of the world economy and high inequalities in material consumption among nations and socio-economic classes are huge impediments in achieving the global vision for a *sustainable future for all* of the United Nation's Agenda 2030, its 17 Sustainable Development Goals (SDGs). This unequal access to resources, resource processing and resource efficiency improvements within and across countries has major negative impacts on global efforts to eradicate poverty, reduce biodiversity loss, mitigate climate change, and eliminate military conflict and social breakdowns across the world.

Deep change is required in the current production and consumption systems in order to deliver higher material standards of living to more people with a lower overall material use and associated environmental impacts of waste flows, pollution, biodiversity loss and climate change. The level of human development necessary for the poorest nations cannot be achieved with the same systems of production and consumption as have been practiced in the industrialized countries and will need substantially different technological, economic and behavioural solutions. Moreover, reducing the environmental impacts of resource use may also require systemic changes to reduce the per capita footprint of material consumption of the affluent, both across and within countries.

Relationship to IRP's Work Programme

Over the decade since its launch in 2007 by the United Nations Environment Programme, the International Resource Panel (IRP) has made major contributions to the analysis and policy implications of the global use of natural resources. The studies and recommendations of the Panel on the importance of resource efficiency in sustainable development, on its economic advantages, and on the various strategies for achieving it have been widely recognized by governments, international agencies and have been incorporated by G7 and G20 Summits in their policy statements. More work remains to be done in detailing the specific measures needed to enhance the speed of decoupling, and the Panel has several continuing work streams addressing this aim. Reports published by the IRP deal with the subjects ranging from broad conceptual concerns that must underlie a more sustainable resource future for the world to specific issues and strategies concerning a wide variety of resources and their management. For the former, an example is the report on the necessity for decoupling resource use and environmental impact from GDP growth. For the latter, an instance is the detailed report on the opportunities for recycling metals. In the current decade, the Panel's work is on practical opportunities for more sustainable resource management focused primarily on raising resource efficiency and resource productivity

From its inception, the IRP has recognized that sustainable management of the Earth's resources involves many factors. The Panel's work on resource governance, trade and global material flows, resource intensity of cities, the pressures on our land and soils, and the resource issues of food security, among others, already testifies to the complex ramifications of managing our natural resources on our economies.

Some of the deeper environmental issues - of how extraction, processing and use of resources impact human wellbeing and social welfare and which resources are likely to suffer from physical scarcity or other supply vulnerabilities clearly needs to be addressed in the coming years. Just as important will be

the need for the Panel to analyse and develop policy options for dealing with inequitable distribution of benefits of resource efficiency and resource efficiency policies themselves. The issues of equitable access by different economies, by different socio-economic strata within economies, and by different actors within each stratum or group have yet to be addressed. To do this, the past work of the Panel and of others will serve as a good starting point, with the addition of some new perspectives -- multi-level, from global to local; multi-sectoral, from land-based activities such as agriculture to technology-based industries and knowledge-based services; and multi-disciplinary, from engineering and economics to social sciences.

At its November 2017 meeting in Lima, IRP agreed to explore the possibility of undertaking an analysis of the equity and other social-economic implications of enhanced resource efficiency, with at least three broad issues that deserved deeper understanding:

a) Can resource efficiency measures alone ensure a sustainable future?
b) What other measures, such as behavioural or regulatory changes would be needed?
c) What is the lower and upper bounds for resource consumption that would be compatible with meeting all the SDGs?

The proposed study is in line with the mandate of the IRP which seeks to attain a holistic, systemic understanding of the full nexus between natural resources and sustainable development. At one end, it is concerned with the extraction, processing, transportation, conversion, use and disposal of the wastes of resources. At the other end, it is deeply concerned with the availability, (geopolitical) supply vulnerability, substitutability and price stability of resources. In the middle are the tough questions of natural resource scarcity and peaking, environmental impacts and equitable (socio-economic) access.

The IRP also focuses on building a better understanding of the governance issues of sustainable resource management. Currently, global resource use is mainly governed by national policies setting the frame for actors within their jurisdiction. The IRP's role is to formulate options for improving international cooperation and UN action and identify gaps in the existing mechanisms for global resource governance. As it evolves, the IRP sees an increasing role for itself providing policy relevant guidance for the implementation of the SDGs. It aims to provide a consistent frame to guide the achievement of various SDGs with direct and indirect relevance of resource use. It aims to show how trade-offs and inconsistencies between seemingly contradictory goals can be resolved, for the benefit of all. (Bringezu S. , 2015) However, resource efficiency and circular economy actons and measures alone are unlikely to result in enabling the poorest to achieve acceptable standards of well-being as envisioned in Agenda 2030. There is a growing recognition that large economic and social disparities are an obstacle to attaining sustainable development. Increasing social equity – and eradicating poverty thus, becomes a primary instrument for environmental and resource conservation. Measures aimed purely at raising resource efficiency, without supporting distributive justice measures will have inherent limits and could lead to missed opportunities[1]. In the absence of sufficiency policies, efficiency gains are cornered by the few and are likely to lead to increased and unsustainable consumption patterns, both by the rich and the poor[2].

II. Rationale and Purpose

1 James D. Ward, Paul C. Sutton, Adrian D. Werner, Robert Costanza, Steve H. Mohr, Craig T. Simmons, Is Decoupling GDP Growth from Environmental Impact Possible? https://doi.org/10.1371/journal.pone.0164733, October 14, 2016

2 Resource efficiency models are unlikely to address the unintended consequences of conflicts of resource use, transference of environmental burden in space and time due to rebound effects of resource-energy nexus. It has been argued that decoupling has often meant resource substitution – which may have a consequence of delayed impacts or shifting the burden in time, space and on stakeholders – thus being inherently iniquitous. They are also unable to respond to spatial boundary limits for resource movement, beyond which resource efficiency gains become counter-productive with increased and distant environmental impacts and local job losses. (Degrowth, 2016)

The conceptual framework of decoupling, promoted as a major goal and an effective strategy by the IRP, supports the global vision for a sustainable future for all of the United Nation's Agenda 2030, its 17 Sustainable Development Goals, and relevant key strategies[3] for implementation [including sustainable production and consumption and Climate Action to enhance resilience and decarbonize growth (Paris Agreement and in particular SDGs 7, 8, 11, 12, 13, 14 and 15)]. Annex 3 of the ToR highlights possible inter-linkages of an SDG with other SDGs. The table also highlights the degree of resource efficiency and equity strategies required to achieve the Sustainable Development Goals. It can be seen that many goals show *high* and *very high* inter-dependencies between resource efficiency and equity. The thrust of the international commitments of Sustainable Development Goals and Paris Agreement boils down to two fundamental priorities: the first is to ensure that all individuals, societies and nations have an equitable access to benefits of Earth's resources as the means to satisfy their basic needs without jeopardizing the same opportunities for others, in current and future generations, the second is to evolve practices that bring the environmental resource base, on which their lives and futures integrally depend, back to its full health and sustained potential productivity. To achieve these priorities requires urgent action on two fronts, through international commitments, to enhance and ensure:

- ***Efficiency in the whole value chain of production systems*****,** as the primary means of reducing pressure on natural resources, such that extracted natural resources can continue to provide value for longer periods for more people without negatively impacting natural eco-systems and,
- ***Sufficiency through moderation in consumption behaviours and strategies for access to resources*****,** as the necessary goal to ensure that enough resources are available to all persons, societies and nations for a decent life without transgressing the various planetary boundaries now and for future generations.

Decoupling natural resource use and environmental impacts from economic growth will limit those production systems that contribute towards superseding environmental limits and will be instrumental in achieving the international commitments. Improvements in production systems over the last couple of decades and new research in technology promises to offer large opportunities for raising efficiency at little or no cost and even improved overall economic performance to enable producers and consumers to get much more with much less. Resource efficiency is thus a "good", capable of delivering "triple win" outcomes for the economy *and* society *and* the environment. The goal of raising resource efficiency is a "low hanging fruit", ripe for widespread negotiation and adoption at all levels. However, there is still a gap in understanding regarding unknown or unintended consequences - both negative impacts and positive value creation of these strategies on socio-economic conditions especially of the poor and developing nations and of equitable distribution of benefits of resource efficiency within and across nations. In one sense, what we are looking at here is about mitigation and adaptation. Mitigation of the adverse potential and impact of resource efficiency and circular economy initiatives which may impact the poor, and the fact that it is possible to devise both mitigation and adaptation. That is the hypothesis to be investigated.

For a sustainable future, strategies *for* efficient use of resources need to be coupled with strategies for equitable access *to* resources within and between countries. There are two important reasons for this, sometimes forgotten or ignored. First, both extreme affluence and extreme poverty generate profound threats to the environment and resource base, affluence by its excessive demand for (usually non-renewable) resources and creation of wastes; and poverty by its dependence on ecosystem services and biological resources that are already fragile, often over-utilizing these beyond their renewability threshold. Second, and equally important, a more fair, just and inclusive society is now widely recognized as a pre-requisite for sustainability and as a basic human right of all citizens. Beyond being

[3] UNEP – IRP report Decoupling Natural Resource Use and Environmental Impacts from Economic Growth.

a moral imperative, equitable access to resources is now becoming a growing political demand and could soon become a pre-requisite for further progress towards sustainable development.

The legitimate demand of all societies for sufficient resources to enable their citizens to live decent and fulfilling lives needs to be met within the limits of the overall resource endowment of the planet. Decoupling through efficiency and circular economy measures are fundamental and necessary, but they remain no more than first steps towards reaching the balance needed between humanity's demands and nature's supply. To attain such a balance with a fair outcome for all, changes will be needed in resource governance, markets, technology, business models, finance, economic strategies and consumption behaviour.

Despite several decades of advocacy for alternative economic models, the global economy and most national economies are still ruled by a virtually total reliance on paradigms of GDP and economic growth[4]. While GDP and other conventional indicators of economic progress will no doubt continue to be important inputs to decision-making, we now need to incorporate measures of other social and environmental outcomes of economic activity[5] to obtain a better understanding of the degree of genuine human progress.

Such full cost accounting is likely to drive shifts in technologies, alternative formulations for systems of production and delivery of services that will demonstrate the principles of distributional equity, and low impacts to the environment in practice. In such a scenario, economies of developing nations can in principle, or potentially be able to leap-frog from primary to tertiary sectors with low resource-to-GDP ratios. This will widen the consumption base, raising consumption towards sufficiency. The secondary manufacturing sectors would, in such a scenario, be largely decentralised, benefiting from high levels of efficiency and aggregation and distribution systems fuelled by information and AI technologies, enabling higher value creation locally.

Purpose of the Study

The primary purpose of the study is to explore factors that impact upon or influence equitable distribution of benefits from resource efficiency and circular economy in different development contexts. It is expected to contribute to a better understanding of resource efficiency strategies from a socio-economic impacts standpoint, providing evidence-based policy options on how to decouple economic growth from environmental degradation while enhancing human well-being.

Relationship between resource efficiency and equity can have two starting points – one can start with resource efficiency and circular economy strategies and look at how to bring more equitable distribution of benefits arising from these strategies. Alternatively, the starting point can be the extent of (in) equity in the world; and to study what resource efficiency strategies best fit to reducing inequities. The study is taking the first approach at this point, while keeping in mind that the latter is also instrumental and shall be explored in further research studies. This is because understanding how the benefits from resource efficiency strategies are (or can be) distributed from the perspective of social equity is a prerequisite to assessing which of those strategies can best reduce inequities.

Following are the primary outcomes expected from the study:

[4]GDP itself is widely accepted now as a poor proxy-indicator of human well-being, also, environmental true cost integration into GDP is inadequate as the implication of distribution of benefits and or of impacts of resource extraction, production and consumption are often (in) equitable and linked to local, national and even global conflicts. The "financialisation of some components of the GDP – that lead to enhanced monetary flows, without a simultaneous increase in energy or material throughput", and finally the decoupling strategy does not affect the increasing separation of production and consumption - which is probably an aspect that impacts distributional inequities in benefits and impacts. Reliance on GDP measures to define national progress leads to policy strategies that enhance consumption.

[5] A large part of the economy of developing nations is informal and decentralised which is not counted in the GDP calculations providing a skewed perspective of the kind of production and service sectors that would "grow" the GDP. The role of the micro and small economies in wealth generation as well as the impact of both informal and formal systems on the eco-systems needs to be accounted for in GDP calculations.

a. A **deeper understanding** through a critical analysis of the **efficiency-sufficiency [floors and ceilings of consumption] nexus** at the sub-national, national and global scales.

b. Identified **features of resource efficiency and circular economy policies** that contribute to equitable distribution of resource efficiency benefits and those that are either neutral or may have a negative impact. The focus of the study will be in four systems: Food Systems, Human Settlements and; Forests.

c. **Case illustrations** that are insightful, science based and relevant to explore the links of efficiency with equity of resource use at local, national and global levels.

d. Policy insights with respect to systems of **governance of resources, markets, technology, finance and trade with resource efficiency and circular economy benefits** to the poor and the health of eco-systems on which well-being depends.

III. Likely Beneficiaries, Target Audiences and Added Value

The work of the IRP improves the understanding of sustainable development from a natural resources perspective, providing science-based policy options that enhance human well-being and allow decoupling economic growth from resource depletion and environmental degradation. Such policy options will enable developing nations to navigate a trajectory for sustainable development. They will also guide the future of consumption in developed and industrialized countries. The work of the IRP will address the questions of trade-offs confronting SDG achievement by countries.

To foster informed and active participation in the design of future development strategies, the **likely beneficiaries** of the study are intended to include the global society, and in particular populations whose lives are especially affected by the environmental and social impacts of resource exploitation, who are often the most vulnerable groups, such as the poor, indigenous societies, small-holder farmers, small scale food producers, landless labourers and women, who depend directly upon natural resources for their livelihoods and to provide for the basic needs of their families.

Target audience: Governments and National policy makers are the primary target audience of the findings of the study to facilitate their policies and regulatory/enabling actions to promote a more equitable resource efficiency programme. Financial institutions and businesses are two other major targets.

The study is also aimed at agencies and stakeholders who influence change and create adequate momentum for change. These include civil society organisations (NGOs, grassroots organizations), media, academia (including national and international think-tanks such as International Council for Science) and business networks and associations (ICC, WBCSD)

This study will also provide evidence-based inputs to help policy-makers and their analysts and other stakeholders gain a better understanding of the environmental, social and economic issues, benefits and pathways (decoupling) to sustainable resource use and management that can inform decision making and policy development.

The study will be presented in two formats: one, an analytic report addressing some of the deeper issues including the questions of trade-offs confronting SDG achievement, accompanied by summary documents and communication materials prepared for policy-makers, the private sector, the media and academia and for any other group identified over the course of the study.

Target Groups	Specific targets in the group	Specific things they need to do
Governments	G20, G7, G77	• Evaluate their national resource efficiency strategies on principles of equitable distribution • Evaluate their inter-nation relations on efficiency and equity and mobilize development funds towards strategies that address equitable distribution of benefits from enhanced efficiency in the use of natural resources.
Multi-lateral institutions	UNEA, UNDESA, WTO, UNDP, UNIDO, UNGC	• UNEA – Evaluate & re-strategize resource efficiency actions on equity – in partnership with UNDP • WTO- Evaluate and re-strategize trade mandates on equity principles, beyond economic efficiency So on for other multilaterals.
Financial Institutions	WB, ADB, AIIB	• International financial institutions to be informed with the need to design their portfolios a focus on **reaching the last mile** with efficiency based solutions. In this way, IFIs can explore to catalyse finance towards equitable distribution of efficiency benefits.
Big Businesses	Multinationals and Trans-nationals	• Big businesses to assess their value chains and incorporate principles of equity as much as resource and economic efficiency for fulfilling the global good on environment. • Specific sector focus will include: Food, Construction, Energy, Transport, Services
Civil society and business networks		• It is expected that civil society, business networks and media will promote, advocate and communicate the benefits of incorporating equity strategies in resource efficiency measures by the target players above and the risks to the fulfilment of the Global SDG agenda if not acting on the same.

Added Value and Policy Relevant Questions

The study is expected to add value to the current development paradigm by:

- Providing **governments** with an assessment of sectoral and or systemic strategies for resource efficiency and circular economy, including the impacts of consumption and the social benefits of resource efficiency/circular economy across income groups. The study will also present some good- practice examples and policy-relevant recommendations that will enable governments to understand how equity can be delivered in policy design and implementation of resource efficiency strategies.
- Providing **financial institutions and big businesses** with frameworks that incorporate resource efficiency and equity in a composite fashion and thus support in evaluating their investment and business decisions.
- Analysing behaviours and interests of stakeholders at the supply side, i.e. raw material suppliers
- Strengthening voice of **civil society, business networks and associations; and media** by expanding the evidence base on the importance of bringing the equity of benefits from resource efficiency into environmental and economic policy-making (rationale and importance of addressing inequalities for sustainable development) and look into how (tools) to do so rigorously (e.g. cost accounting, systems thinking, others).
- Defining the contours of “inclusive strategies for decoupling and resource efficiencies” and open newer areas of research for **academic institutions**.

- Inform integrated approaches at **intergovernmental bodies** working on sustainable development (e.g. HLPF, UNEA, UNDESA, G7, G20, ILO, WTO, among others).

IV. Summary of Knowledge Review

This section reviews existing knowledge pertaining to use, efficiency and distributional aspects of resources. It begins with reviewing trends, within and across countries, to study connections of resource efficiency strategies and its impacts on equity. This is followed by sectoral assessments on identifying resource efficiency strategies and their impact on equitable outcomes in that sector – both at production and consumption levels. The last section reviews existing policy and market strategies and their role in determining impacts on equity and resource efficiency.

Review on state of resource efficiency and equity, within and across countries:

Material footprint, a measure of the material requirement of the consumption and infrastructure system of a country (Wiedmann et al., 2015) indicates the material flow based environmental pressure of final consumption across the entire value chain. From the literature reviewed, it can be stated that on a per capita basis, high-income countries still consume 10 times more materials than low-income countries. Material footprints have somewhat stabilized in high-income countries and have grown strongly in upper-middle-income countries (and to a lesser extent in lower-middle-income nations). On the other hand, low-income countries rely on a very small per capita material footprint with no significant increase in per capita natural resource supply over the last 30 years.

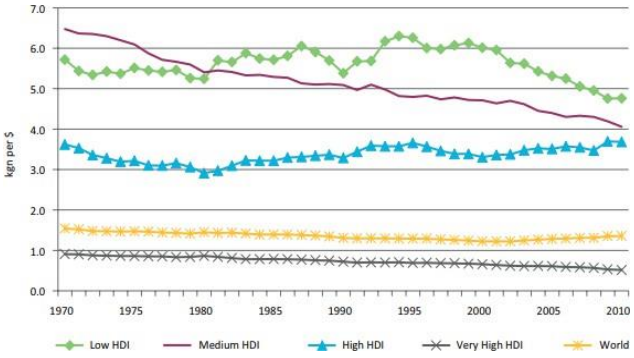


Figure 1: Material Intensity of economies, as per development status of countries

By studying the **material intensity of economies** across the globe (Refer Figure 1), it is further important to note that countries with Lower and Medium Human Development Index (LHDI and MHDI) are highly dependent on high material use for economic growth, given their industrial mix, despite having a lower consumption footprint at per capita level. The LHDI and MHDI countries require 6 to 10 times more materials to produce a unit of GDP than the group of VHDI countries. LHDI and MHDI countries need to explore ways in which efficiency and economic growth can realise better human development outcomes. VHDI countries should optimize their resource consumption, based on the fact that their resource use occurs mostly at domestic household level. (IRP, 2016)

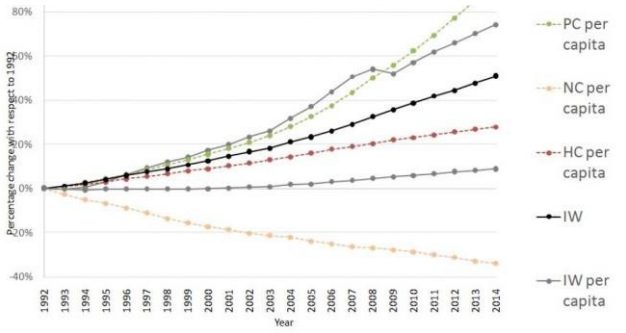


Figure 2: Inclusive Wealth, Global, 1992-2014

The Inclusive Wealth report 2018 (Refer Figure 2), country-wise, also highlights the negative per capita growth of inclusive wealth in many countries, despite increase in GDP per capita. Natural capital, according to the latest report, declined in 127 out of 140 countries. Developing country Natural Capital depreciation has been on average five times higher than in OECD economies. In low- and middle-income economies Physical Capital and Human Capital have compensated for the rising Natural Capital depletion since 2000. Over time, loss of Natural Capital is expected to damage the sustainability of development efforts and worsen inequality.

Regional differences in the causes and effects of efficiency also vary. For instance, in the case of food losses and waste, at consumption and pre-consumption stages, there are high levels of consumer waste in industrialised countries (Refer Figure 3). Supply-chain waste is also significant in industrialized countries, due to economies of scale and the "super-

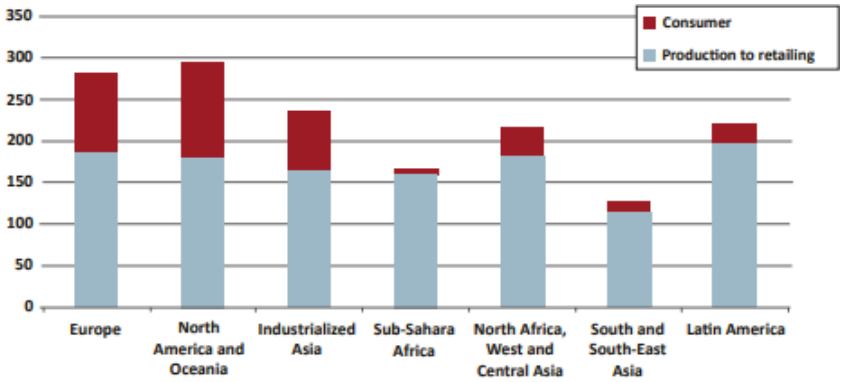


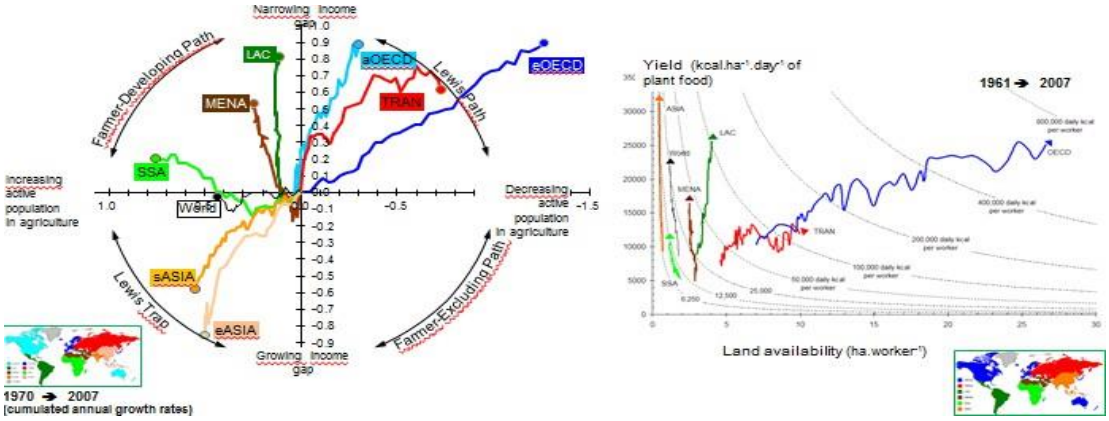
Figure 3: Per capita food losses and waste, at consumption and pre-consumption stages (kg/year)

marketization" process, whereby high levels of waste are a by-product of a system geared towards ensuring shelves are continuously stocked with products that meet high uniform cosmetic standards, as well as basic food quality standards. (Gustavssion et al., 2011)**Review of Sectors and Systems**

A review of studies that highlight issues of equity and resource efficiency inter-twined across economic sectors and within socio-economic and ecological systems are summarized below. Annex 2 includes reflections on possible approaches to enhance resource efficiency and an equitable distribution of benefits thereof 2.

Trends in the world on equity in **agriculture** (Refer Figure 4) show that 55% of the 2007 world population (29 nations of 1970) have embarked upon a Lewis Trap (increasing population in agriculture + increasing income gap between agriculture and other sectors) since 1970; 16% upon a Farmer-Developing path (49 nations) (increasing population in agriculture + narrowing income gap) and; 29%

Figure 4: Labour income gap of Asian farmers widened despite best growth and ranking in yield



upon a Lewis Path (46 nations) (Decreasing population in agriculture + narrowing income gap) Strategies of resource efficiency and development of the agriculture sector need to take into account the excess labour that this sector currently absorbs - thus providing livelihood benefits to the majority of the population in developing countries. Historical evidence corroborates that higher land acreage per farmer was the main driver for boosting agricultural labour productivity and convergence of incomes across sectors. This has led to monocultures and low resilience to economic and climate shocks in the OECD in the 19th-20th century. This is causing faster depletion of natural resources (soil, water) and adding risk of severe social and political crises in 20th century Asia today. (Dorin, 2013).

The resource demand from the agriculture sector is closely driven by **food consumption patterns** worldwide. Dietary habits across the world are the leading cause of disease. Some 800 million people worldwide still suffer from hunger, while more than 2 billion are overweight or obese. As much as 57% of the global greenhouse-gas emissions come from food-related activities, which include everything from clearing land for agriculture, to growing, gathering, processing and packaging, to transporting farm goods and disposing of waste. (TEEBAgriFood, 2018) *Gopalan (2001)* analyses the differences in consumption patterns, with an increase in affluence, the trend of moving up the food chain is seen with an increase in demand of meat, poultry and seafood. Food waste and loss are a characteristic trait of food systems, with 20-30% of agricultural produce being lost for food intake. The quantities and the distribution of food losses and waste at consumer level and production to retailing level differ significantly across countries: the share of food waste at consumer level is higher in high-income countries than in middle- and low-income countries (in Sub-Saharan Africa, practically all losses occur at production to retailing level). (IRP, 2016)

Household consumption of **manufactured goods** has witnessed an increasing trend, across the globe, with a steeper growth curve in developing and industrialising economies – given their development trajectory. The diffusion of most societal consumption goods follows the traditional S-shaped pattern: At first, only a few individuals adopt the new good, but soon diffusion begins to climb, as more and more households adopt it. The rate of adoption then begins to level off, as fewer and fewer households remain that have not adopted the product. Eventually, the S-shaped curve reaches its asymptote. The good has become a mass product. Changes in demand patterns as countries develop and the massification of consumption are closely linked to the emergence and consolidation of domestic manufacturing industries. (UNIDO, 2018) But models and technologies in the manufacturing sector have become efficient at the cost of equity. Huge imperatives on job loss with increasing automation on one end, new skill sets not possessed by poor and disregard of labour rights and jobs in manufacturing epicentres like SEZs raise critical issues of equity. Average consumption bundles are larger in countries with higher GDP, indicating that the variety of goods consumed tends to increase with economic development.

New approaches of sharing economy to reduce resource consumption across **systems of manufacturing and services**, are subject to questions on the impact on equity. Uber, for example, has brought about efficiencies in mobility through shared car-hire services with obvious positive effects on reduction of car ownership and consumption. However, Uber's longer-term impact on labour standards is quite unclear, as are its implications for the future of low-wage work more generally in the sector. Further, the price competition and therefore the motivation to promote and use mass public transport facilities where they do not exist yet, is also a rebound effect likely to impact both universal access and energy efficiency of mobility options. Another example of real estate sharing is the Airbnb that offers affordable accommodation to tourists and short term visitors without having to create more physical infrastructure. Economic incentives have driven Airbnb to reach to larger markets in shorter spans of time. But such a market is creating shortages in local immediate social circles. This is pushing affordable housing out of reach of many low-income families. More market-sourced income to asset owners in Airbnb may or may not be recycled back locally through taxes and other fiscal measures.

In the case of **human settlements** systems, it is yet to be studied how factors such as density or spatial planning aiming at resource efficiency impact equity aspects – including the poor and equitable access to resources for all. Studies indicate that the magnitude of material requirements for cities is related to their populations and occupation of space, but the direct material intensity of cities (tonnes per km2 or tonnes per hectare) is related to the way that space is filled and connected with infrastructure (buildings, transport and communications infrastructure) and to the provision of basic services. A general pattern exists of cities with a high population density having lower urban DMC per capita, but there is considerable scatter in the data at global and regional levels. North America appears to be a special case, where urban DMC per capita has no relationship with urban density.

The human settlements in rural and non-urban areas of the world are confronted with inadequate access to poor quality resources for their subsistence level living. Resource efficiency strategies in these contexts often result in local and short term relief that may or may not be sustainable over longer timeframes. The case of water resources is at the core of sustainability of life in these areas. Significant rural-urban disparities are evident in both sanitation and drinking water coverage, for instance. Globally, 51 per cent of the rural population use improved sanitation, compared to 82 per cent of the urban population. Out of the 2.4 billion people without access to improved sanitation; seven out of 10 live in rural areas. For drinking water, there are marked differences in both the level of service available to rural and urban residents as well as the absolute numbers of people without access to improved drinking water. Just 32 per cent of the rural population has access to piped water on premises compared to 79 per cent of the urban population; and eight out of 10 without access to any type of improved drinking water live in rural areas. (UNICEF, 2015) Access to water and sanitation further exacerbates livelihood insecurities in the rural region. Some of the common drivers of such inequities are connected to higher resource efficiency and economic productivity benefits accrued by industrial and urban use.

The global economic system is heavily dependent on forests. Approximately, 1.6 billion people worldwide are reliant on forest ecosystems as their source of income, therefore playing a vital role in efforts to reduce poverty (United Nations, 2015). Approximately 300 million people live in forests, including 60 million indigenous people (United Nations, 2015). Forests also provide habitat for wildlife, often economically important to the local population. The UN estimates that about 75% of the world's poor are affected by forest degradation and deforestation (United Nations, 2015, p. 1). According to the FAO, the forest sector contributes approximately 0.9% of global GDP, and creates employment opportunities for over 50 million people worldwide.[6]

Apart of formal systems and sectors, developing countries thrive on a very large informal economy that supports the poor segments of the society for their daily subsistence. As the report will study enabling conditions towards distribution impacts of resource efficiency strategies, it will keep in mind how pathways for resource efficiency and circular economies can incorporate the informal chains of resource use and exchange and build access to such strategies to the poorest. This will also involve studying the changing patterns of skill requirements and jobs with the transition.

Review of Strategies

The final part of this section focuses on reviewing existing policy strategies used to address issues of efficiency and resource access.

Governance strategies are studied under two broad categories: governance of natural resources at the local and sub-regional level, and international governance norms and mechanisms. Governance of natural resources studies the nature of ownership, management and decision making on the use of resources, which has a relationship with the efficiency of use and equity of access to natural resources. Works of Ostrom, Wade, Baland and Platteau were reviewed to develop an understanding on common property resource management. Economist Hernando Desoto's work on property rights, informality and its relation with economic growth and inequalities is instrumental in the area of regional resource and economic governance (Williamson, 2011).

States now face global challenges, the resolution of which will require the development of processes that rely on a wide range of actors and various forms of governance, international law and political globalization. Furthermore, the emergence of new powers is an opportunity to boost cooperation, since there may be a better balance of power in the international system, so that dialogue and consultation seem to be the best and most realistic relationship strategies among the various powers (Pereira 2013).

[6] https://epi.envirocenter.yale.edu/2018-epi-report/forests

Le Billon (2012) argues that resource allocations, operating practices, social rights and the discursive representations contribute to shape vulnerabilities and opportunities for the emergence of armed conflicts, which means that, in many cases, security problems are originated within a state, but have a large potential to surpass national borders and affect regional and international security. The idea of future conflicts over scarce resources and anthropogenic environmental change need to be considered in terms of particular geographies of vulnerability, threat and insecurity, as well as the new dynamics associated with globalization.

Profit sharing and rent sharing have been debated and deliberated as some of the important measures for building equity in production systems. Empirical studies show that profit sharing can deliver significant benefits to employees, through higher earnings and employment stability, and to employers, through higher workplace productivity, which again supports higher employee earnings. Studies show that profit sharing can also have significant impact on wage rates and employment status of the region (Fang, 2016).

Institutional systems of transparency and accountability are critical elements of checks and balances in an economy for ensuring equitable access to and distribution of benefits from resources. They enable scrutiny by the larger polity on a wide variety of issues ranging from ecological, technical and economic viability, social justice and efficacy of decisions but most importantly on malpractice and corruption, both direct and structural. Corruption is often undertaken as a means of overcoming efforts to transfer resources through regulation. Corruption tricks the market, and the legal order of the market, to transfer resources to the hands of few at the expense of community. To prevent such phenomena, policies and regulatory engagement need to scrutinise and incorporate the signals and characteristics of the market. Corruption practices cause the public to bear negative economic consequences (social costs), most likely leading to misallocation of resources. The economic analysis of corruption and bribery shows, in fact, that corruption hinders investment (both domestic and foreign), reduces growth, restricts trade, distorts the size and composition of government expenditure, weakens the financial system, and strengthens the underground economy. (Minto, 2018) With the development of circular economy the transparency in waste management system both in physical trade (CWIT,2015) and financial rules i.e. by implementation of Extended Producer Responsibility (EPR) can be crucial for decoupling and sustainable future.

Power has become an important subject in the discourse of development. In conventional analysis, development can be seen in terms of evolution of theories and ideas, or as the succession of more or less effective interventions. For political economists, the same history reflects deferent ideological responses to allegedly deeper contradictions, dictated by capital accumulation and circulation, or also capital accumulation and legitimation. This history, however, can also be seen from the perspectives of the changes and transformations in the discursive regime, even if these changes are circumscribed by discursive practices tied to political economies, knowledge traditions, and institutions of ruling, and wherein lies the notion of power. (Islam, 2009) Power dynamics set the tone at almost every level of human interaction. Given the varying levels of acceptance of imbalanced power structures (e.g. authority, institutions), formalized development institutions for instance, conventionally funded by developed nations could experience different degrees of resistance *or* welcome from local communities in the developing world. In both cases, effective communication—especially power-conscious discourse—plays a key role in building a positive and trusting relationship between the institution and the locals. (Guo, 2014) It becomes critical to therefore study the power dynamics and power asymmetries in determining actions on resource efficiency strategies, keeping in mind the distributional impacts of such strategies.

Costing and pricing of products and services in the market and the relevance of true costs in the price has an impact on consumption patterns. Governments attempt to manage this through various strategies so that access to basic goods and services is not denied to the poor. However, these strategies may or may not have positive impacts on driving efficiencies in production. Further, the nature of financial markets, technological markets and trade of goods and services at national and

global levels also affect whether efficiency gains in the true sense are equitably distributed and are leading to poverty eradication. **International trade** has the potential to make substantial contributions to global resource and impact decoupling guided by appropriate policies on environment and trade as acknowledged in the UNEP report on decoupling (2011). Most industrialised 'developed' countries are primary importers of raw materials while poorer countries in Africa and Latin America are importers of manufactured products. As materials move, from the raw material stage to manufacturing, they increase in economic value and decrease in weight, leaving behind emissions. The poorer countries, therefore, are accessing goods at higher value and cost, also with the added environmental impacts of material extraction. The emerging economies are currently where the transformation from raw materials to goods is happening and would have benefited from job creation, however in light of increased capital efficiency driven production systems and growing automation, this benefit is not adequately realized as fewer and fewer jobs are created in the manufacturing sector. **Technology, automation and new business models** determine the trajectories of production systems and the way markets will evolve towards resource efficiency and circular economy. Such evolutions and changes in the production systems, impact on the nature of jobs, employment and working conditions. Scenarios by a McKinsey Study (2017) suggest that by 2030, 75 million to 375 million workers (3 to 14 per cent of the global workforce) will need to switch occupational categories. (McKinsey Global Institute, 2017) It further states that major transitions lie ahead that could match or even exceed the scale of historical shifts out of agriculture and manufacturing. Even as it causes declines in some occupations, automation will change many more—60% of occupations have at least 30% of constituent work activities that could be automated. A study by Global Goals Technology Forum quotes that technological change was responsible for 85% of the 5.6 million manufacturing jobs lost in the US between 2000 and 2010. Technology could have particular consequences for countries which rely on sectors which employ large numbers of unskilled workers. For example, China-based Tianyuan Garments Company, the largest apparel supplier to Adidas, recently announced plans to produce t-shirts in the United States using automation to allow customization, faster speed to market. (Global Goals Technology Forum, 2017) Additionally, newer sectors like that of recycling will displace or change the nature of the work, for people engaged in it like waste pickers. It is important to therefore study aspects of equity on the lines of such transitions.

V. Scope and Content of the Proposed Report

The underlying premise of the study acknowledges the existence of competition for finite natural resources and the extreme inequities in resource access and use by different socio-economic groups. The starting point of the research is to understand the extent of impact of these inequities – of extreme impoverishment and affluence, on achieving overall well-being within planetary boundaries. The **primary research question** of the study is:

How can policies and strategies for enhancing resource efficiency and circular economy also lead to well-being for all?

The study will conduct research and analysis to explore answers to the following **research questions**:

1. What is the relationship amongst wealth, well-being and successes of resource efficiency; and what are the socio-economic impacts of improved resource efficiency and circular economy practices on income and wealth distribution of nations/regions?
2. What are the factors that enable/inhibit equitable distribution of benefits from resource efficiency measures within and across countries/regions?
3. What are the factors that enable/inhibit equitable access to resources within and across countries and regions?
4. What are the main challenges that need to be addressed to ensure an equitable distribution of the benefits arising from resource efficiency and circular economy strategies in order to achieve the 2030 Agenda for Sustainable Development?
5. What are policies and strategies that have been successful in raising resource efficiency and also reducing inequities; and in what contexts? How do these contexts relate to the main challenges identified in response to question 3?
6. What policy options offer trajectories to higher efficiency and higher equity futures? Which of these policy options are the most important to be considered by decision makers to achieve the 2030 Agenda for Sustainable Development?

Table 1 below elaborates on the proposed framework of the Study

Methodology

The study will use the following methods of research:

1. Relationship of wealth and well-being and successes of resource efficiency and circular economy	
• State of Production Systems (Sectors); Patterns of material consumption • Inter-country comparisons on material footprint/HDI/ Inclusive Wealth • Intra-country comparisons on GDP's material footprint, poverty	• Trends and analysis from existing studies – IRP data; World Bank Data, Inclusive Wealth Data, HDI
2. Factors that enable/inhibit equitable distribution of benefits from resource efficiency and circular economy (RE) measures[7]	
• Resource efficiency – Equity nexus studies in three or four systems: Food Systems, Human Settlements, Manufacturing & Services, Land & Forests. • Strategies employed in different contexts - identifying the extent of "slack" where better equity is possible for given RE strategy and context-specific trade-offs between equity and RE • Factors within RE strategies that influence equity outcomes	• Case study analysis of the systems
3. Policies and strategies that have been successful in raising resource efficiency & reducing inequities	
• Fiscal instruments and regulation • Market instruments Governance of resources and production systems (Policy strategies will reflect two types of changes – • Incremental – *that leads to short term improvements* • Systemic / structural – *that leads to long run shifts)* (Case studies will be on country and/or sub-country strategy level, which by its very nature, will be mixed strategies, containing resource efficiency as well as equity related elements.)	• Policy trajectories • Case studies

Case studies will be central to the methodology and analysis. They will build the arguments both as evidence of the relation between resource efficiency and equity aspects of efficiency gains leading to impacts on poverty eradication; and, for identifying strategies that countries may adopt for building equity into resource efficiency polices that address the main challenges identified in Chapter I.

- It will draw upon IRP reports and external literature to map the status, trends, and patterns of resource use in production and consumption systems, studying horizontally across socio-economic groups and vertically across local, regional and global levels.
- The study will take case examples from specific sectors and regions to study direct and indirect impacts of resource efficiency and circular economy strategies on aspects of equity across value chains and society (parameters identified in the structural frame of the study). A number of potential case studies will be identified from across the globe that provide insights on inclusive resource

[7] Historically, strategies for poverty eradication, as identified in the scoping meeting, have included mass employment, mass income transfers, education, migration and labour movements. The future may need to address mass entrepreneurship and localization of production as additional strategies. The study will take this in cognizance while studying for factors that enable/inhibit equitable distribution of benefits from resource efficiency measures.

governance and how efficiency benefits have translated to populations benefiting with respect to their access to resources, or where resource extraction has reduced access to resources by certain communities.

- The study will build scenarios around policy, governance and market strategies pertaining to resource efficiency and equitable access, to study the variation in impact on well-being for all. (Parameters identified in the structural frame of the study). It will build its approach based on existing methodologies like the three-horizon methodology.
- The study will identify emerging policy lessons and strategies that can support governments to develop more inclusive resource efficiency and circular economy policy frameworks, mitigate unintended negative impacts of resource efficiency on equity and wellbeing and build in positive feedback loops in resource management and use systems. Such integrated policy strategies will aim to provide insights on fulfilling the Sustainable Development Goals.

Systems, Sectors and Thematic Scope

The study will identify those systems that have a large job creation potential as a sector. It will also assess systems on maximum impacts on the environment due to volumes of extraction and pollution. The following systems will be studied as a part of the study:

Systems	Sectors	Resources
Food Systems	Agriculture, Food consumption	Land, Energy, Water
Human Settlements	Construction, Transportation (the inclusion of Communications will be explored through the research phase), Access to Energy	Land, Energy, Minerals, Metals, Water
Forests	Manufacturing (Paper, timber, NTFPs) and service industry	Land, Water, Bio-mass, Energy

Given the limited resources available for this project, a fine balance will need to be established between the need for focus on a few selected sectors and the need for representative examples of sectors and resources.

Geographical Scope of the Study

The scope of the report will be global, with regional specificity, and illustrative examples from across the globe, both at national and sub-national levels. Findings will be presented as far as possible according to differentiated country status – including developed/developing, middle-income, and emerging, countries in transition, primary exporters/importers, producers and consumers, and by endowment of natural resources among others. These categorisations have different implications in terms of messaging and actions regarding resource efficiency and sufficiency.

Expected Key Messages for Policy Options:

- **Governance:** Institutions for foresight analysis and various level, especially looking at inclusive processes and participation of local communities and civil society:
    - **Addressing conflicts from resource scarcity perspective** - environmental factors positioned into a broader and more complex framework where scarcity directly leads to conflict.
    - **Profit sharing as measures for building equity in production systems** - can deliver higher earnings and employment stability, as well as higher workplace productivity.
    - **Checking Corruption practices** – Corruption leads to misallocation of resources and thus hinders investment, weakens equitable benefits.

    - **Reducing Power distances** – By studying power asymmetries and their consequences on actions of Resource efficiency and circular economy
- **Regulation and Fiscal Measures**: Reduce negative un-intended consequences or correct them when they occur
    - **Boosting green taxes in sectors** such as waste management, water supply and management and renewable energy production
    - **Introduction of an "inclusive" criteria in existing taxes**, and the elimination of fiscal benefits in polluting sectors
- **Market, Technology Finance and Trade:** Incentives for promoting efficiency and encouraging sufficiency behaviour
    - **Full cost accounting** - Rethinking the resource and inclusion balance sheet in business and public service.
    - **Costing and pricing of products and services in the market -** true costs in the price has an impact on consumption patterns.
    - **Investing in People, Jobs** - increased capital efficiency and growing automation in production systems must not hinder distributive benefits of production systems

VI. Structure and Presentation of the Report

Chapter I will be introductory. It will define the terminology used throughout the report and lay the base of development context, highlighting the most significant aspects of the economy that are driving global issues of resource consumption and inequity and identifying the priority challenges to be addressed by decision makers within the framework of the 2030 Agenda for Sustainable Development.

Chapter II shall explore the link between resource efficiency and equity and thereby its impact on achieving overall well-being, especially of the most impoverished.

Chapter III, in line with the priority challenges identified under Chapter I, will focus on a systems review of resource efficiency and circular economy strategies and aspects of equity that impact the distributional patterns of resource use.

Chapter IV will give an insight on the way forward towards the 2030 Agenda for Sustainable Development, providing a frame for enabling and inhibiting factors in addressing distributional aspects of resource efficiency strategies to enhance wellbeing while staying within the safe operating space.

Chapter V will suggest policy guidelines with respect to resource governance, market systems and institutional structures that promote inclusive models of production systems (resource efficiency and circular economy) and moderation in consumption patterns (resource sufficiency) across and within nations to solve the priority challenges identified with a view to achieving the 2030 Agenda for Sustainable Development.

Table 2 below elaborates on the Proposed Structure of the Report

Chapter 1	Development Context: Background
	• Definition of terminology (e.g. 'resource efficiency' as compared to 'circular economy', 'efficiency strategies', 'equity/inequity', 'social breakdown', etc.) • Efficiency of Resource use – Production Systems and Consumption Patterns • State of Inequities – Access to Resources, Incomes, Wealth • State of Economy – Material Intensity, Income disparities • Identification of a limited number of key challenges to be addressed arising from the above analysis with a view to achieve the 2030 Agenda for Sustainable Development (see Annex 3 for inter-linkages between the SDGs and the related resource requirements).
Chapter 2	**Exploring distributional aspects of resource efficiency and circular economy**
	• Relationship of distributional equities with decoupling through resource efficiency • Factors that enable/inhibit distributional equity of resource efficiency benefits – Historical evidence, potential • Role of international trade/globalisation on distributional equity of resource efficiency (This chapter shall use case studies to illustrate relationships and identify enabling/inhibiting factors for distributional equity of resource efficiency benefits)
Chapter 3	**Systems Review of Resource efficiency and circular economy strategies and their impact on distribution***
	Resource efficiency – Equity nexus in the following systems: Food, Human Settlements (Construction and transport), Forests, Manufacturing & Services. Strategies employed in different contexts: • Factors that enable/inhibit equity benefits from resource efficiency strategies • Role of Governance of resources and decision making institutions • Financial, technology and market ecosystem levers identified (The systems identified, will be studied through case studies, which will include both qualitative as well as quantitative analysis of the case in point. The case studies will support recommendations that solve challenges identified under Chapter I.)
Chapter 4	**Policy Scenarios and options for optimum outcomes**
	• Policy Scenarios to realise distributional benefits, without compromising, rather enhancing efficiency benefits for Food, Human Settlements (Construction and transport), Forests, Manufacturing & Services • Analysis and conclusion on policy design to build resource efficiency and circular economy policies that avoid inequality and deliver equality and mechanisms to ensure that these are implemented
Chapter 5	**Imperatives, Conclusion and Recommendations**

	• Conclusions and Recommendations to solve the key challenges (to different target groups)
	• Approaches and strategies available to decision makers in different contexts
	  • The approaches and strategies will be tailored by type of decision maker in line with the target audiences identified for this report
	  • The report will aim at establishing which approaches and strategies are most needed to solve the key challenges
	• New research areas for future work

*Based on inputs received by experts involved, Chapter 2 and 3 may be merged into one, during the course of the study.

VII. Available Expertise

Academic Research Institutes: University of York, University College London, LSE, University of Cape Town, Stellenbosch University, SEI, ICSU, JNU, TISS, University of Sussex

Civil society and other Stakeholder Networks: UN Poverty Environment Initiative (UN-PEI), Green Economy Coalition, Green Growth Knowledge Platform, Circular Economy Forum *(need to check),* UN, UNE-IRP Members

Foundations/Other Research Organisations: Oxfam, IUCN, WWF, GIZ, IIED, ODI, WRI

Data bases: World Bank, UNE, Human Development Reports, UNIDO data, World Poverty.

VIII. Authors and Contributors

Coordinators (to be confirmed): Dr Ashok Khosla and Zeenat Niazi, Development Alternatives India.

Contributions expected from IRP members:

Vijay Kumar, Eeva Primmer, Michael Obersteiner, Anders Wijkman, Anuradha Ramaswamy, Bing Zhu, Saleem Ali, Helga Weisz, Hans Bruyninckx, Keisuke Nansai, Min Jin, Francis Bisong, Patrice Christmann.

Contributions expected from Joana Kulczycka (AGH), Dr. Nitin Pandit (ATREE, ex-WRI), Dr. Veena Joshi (independent consultant, ex-SDC, TERI), Andrew Farmer, Anshul Bhamra (Development Alternatives), Jitesh Khosla *(*IAS, retd, Development Alternatives), Medha *(*Development Alternatives), Namasi Araou, Julia Steinberg, Klaus Uberchikt, James Boyce, Sam Bowles, Leida Rijnhout, Bhim Adhikari (tentatively for peer review only)

Lead Authors		Ashok Khosla, Zeenat Niazi
	Who?	**What?**
IRP	Vijay Kumar	Relationship of distribution equities with decoupling through resource efficiency
IRP	Eeva Primmer	Systems review of resource efficiency strategies on their impact distributions • Identifying factors that enable/inhibit distributional equity of resource efficiency benefits • Role of Governance of resources and decision making institutions • Financial, technology and market ecosystem *(in respective identified sectors)*
IRP	Anders Wijkman	
IRP	Anuradha Ramaswamy	
IRP	Min Jin	
IRP	Joana Kulczycka	
IRP	Francis Bisong	
IRP	Helga Weisz	
IRP	Hans Bruyninckx	
IRP	Keisuke Nansai	
IRP	Michael Obersteiner	Policy Scenarios and Options for Optimum outcomes
IRP	Andrew Farmer	
IRP	Leida Rijnhout	Review of chapters and analysis
IRP	Bhim Adhikari	
DA	Veena Joshi	• Relationship of distribution equities with decoupling through resource efficiency • Systems review of resource efficiency strategies on their impact distributions • Policy Scenarios and Options for Optimum outcomes
DA	Nitin Pandit	
DA	Jitesh Khosla	

It is expected that the study will engage with more experts and practitioners over the course of its time, and may expect more contributors to the study – as input-providers to the chapters, reviewers, participants at brain-storming workshops.

IX. Work Plan including timeline, outreach and dissemination

Deliverables/Activities	Key Milestone	2018	2019	2020	2021
Discussion on the ToR at IRP meeting	Presentation of the Terms of reference to the IRP	October			
Scoping Workshop	Develop and freeze the framework of analysis with core research group/team		March		
Final agreement of ToR	Terms of Reference confirmed by IRP Board and Authors		October - November		
Working Group meeting	Review and deliberate progress in research		November		
Presentation of the first draft of the report to the IRP	Review and deliberate progress in research, major findings, gaps of the study			December	
Final draft of Report for inputs and approvals	Share the final draft of the report/study with IRP				April
Final Report	Editing, layout, printing and translating				June
Dissemination	Policy engagement and dissemination of the report at various platforms				Possibly at HLPF, SDG, G20 Summit, among other opportunities to be explored

Important dates for sharing and dissemination:

G20: Saudi Arabia (2020), Italy (2021), India (2022)
G7: USA (2020)
G77: *to be decided* New York (2020)
HLPF: July 2020
UNEA: 2021

X. Financial and team requirements (in USD)

for the Report proposed to IRP on
"Socio-economic implications of enhancing resource efficiency" (HIPA 3)

S.no.	Budget Head	Requested from UNEP	Remarks
A.	**Research Costs of Development Alternatives[8]**		
1.	Technical Inputs (DA)	140,000	DA research costs include, @domestic charge rates[9] • 1 senior researcher half time, • 1 junior researcher half time • 2 research assistants half time • Accounts & administrative support
2.	Technical Inputs (Experts)	30,000	• Experts contributing in developing part of the research theme/topic
	SUB TOTAL A (USD)	**170,000**	
B.	**Consultation, Publications**		
3.	Technical Inputs (Experts-IRP)	20,000	4 to 5 external part-time experts for collecting data, case studies and presentation materials
4.	Workshop/ working group meetings (2 overall)[10]	45,000	15 participants/ workshop with an average cost per person @USD 1400
6.	Publications and dissemination	50,000	These activities could also be taken up directly by the secretariat.
	Sub-Total B (USD)	**115,000**	
	Total A+B (USD)	**285,000**	

Note: the above figures, as discussed on the call, are open to adjustment to make them acceptable to Steering Committee.

[8] *Office expenses, communication for online discussions shall be borne by Development Alternatives.*
[9] *Dr. Khosla's time, and differential of charge rates between international and domestic rates of the researchers will be contributed by Development Alternatives.*

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IV. Description of Core and Potential Products 2026-2029

Contents

CORE PRIORITY PRODUCTS

Current Products

HIPA-1: Current trends and future prospects for global resource Use and Sustainable Resource Management

Global Material Flows Database (GMFD)(Phase III)

Status: Terms of Reference were approved at the 32nd IRP meeting and are annexed to the IRP's 2026–2029 Work Programme.

The Global Material Flows Database (GMFD) is one pillar of the empirical foundation of the IRP's analytical work. It provides comprehensive, harmonized, and policy-relevant data on global, regional, and national material extraction, trade, and consumption. Phase III of the GMFD, was initiated under the 2022–2025 Work Programme.

Phase III of GMFD development will consist of an update of territorial and footprint accounts, including a forecast into 2028 to support the development of the Global Resources Outlook 2028 report. Further, an extension to cover material stocks and outputs will be made, requiring outflow estimates, including solid waste landfilled, emissions to air and water, and the dissipative use of products. This data will be of direct relevance to SDG target 12.5. Extension to circular economy related indicators, based on the work of the UNECE Task Force on Measuring the Circular Economy is expected to address questions such as: current circularity rate for each country, maximum achievable circularity rate, quality of materials kept in stock and generating value and revenues, or the contribution of secondary materials to the overall national economy. The final selection of indicators will be discussed with the IRP Steering Committee.

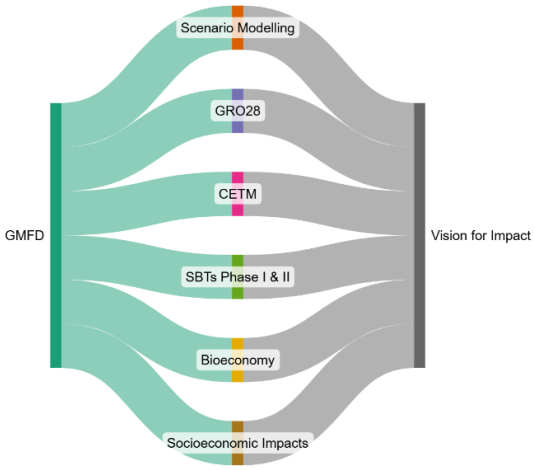


Figure 1: Relationship between GMFD and Core Priority Products 2026-2029

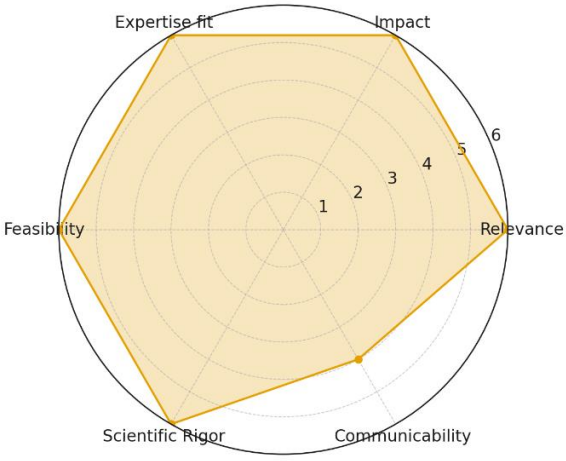


Figure 2: GMFD evaluated against 2026-2029 Criteria for Assessment

Impact Potential: The GMFD is a critical enabler for nearly all IRP research outputs in the 2026-2029 work programme. It contributes to all four pillars of the IRP's Vision for Impact. It supports governance by strengthening the global data architecture for sustainable resource

use; helps stakeholders understand the linkages between economic growth and material use; and provides official data to report on SDGs 8.4 and 12.2. It advances regionalization of IRP work by enabling granular, country/region-specific analysis, and provides data for UNEP tools such as SCP-HAT. Finally, it underpins provisioning systems and circular solutions by offering reliable material flow metrics, which have been used by the private sector, international organizations, academia and other stakeholders. The GMFD is also widely used by international institutions, statistical agencies, and national governments - enhancing the IRP's visibility and policy relevance in processes such as UNEA and circular economy initiatives.

Rapid Study on Approaches to develop science-based targets of natural resource use (Science-Based Targets)

Status: First draft of the Rapid Study was approved for external peer review at 33 IRP. The outcomes of the Peer Review will be presented at 34 IRP, and second draft expected for approval in Q1 2026. Launch is expected in Q2 2026.

The rapid study presents a systems approach to science-based target (SBTs) setting for a sustainable use of natural resources that considers multiple dimensions, including: different stages of the Driver, Pressure, State, Impact, Response framework (DPSIR) and policy cycles; time; geography, resource type; socio-economic benefits of raw material use; and level of jurisdiction. This approach is intended to guide a quantitative assessment of synergies and trade-offs between existing and planned resource use and other targets, such as climate change targets or the SDGs. In addition, the study defines a set of criteria for aggregated material categories such as conditional growth, conditional convergence and maximum reduction.

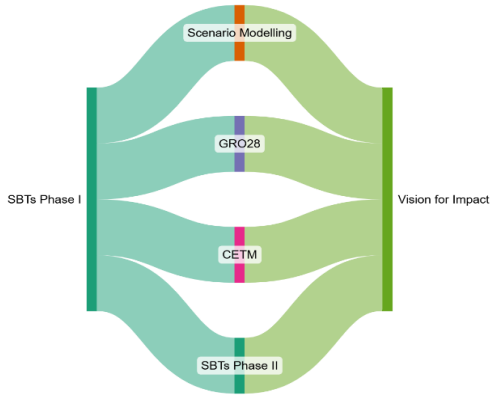


Figure 3: Relationship between SBTs Phase I and Core Priority Products 2026-2029

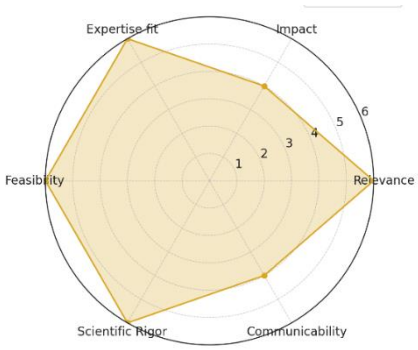


Figure 4: SBTs Phase I evaluated against 2026-2029 Criteria for Assessment

Impact Potential:
This work will contribute to all pillars of the IRP's Vision for Impact. It supports governance by demonstrating the need for SBTs and providing a systems approach for setting targets at national, regional and global level. The study strengthens the case for redirecting finance toward sustainable resource use, by offering science-based criteria that can guide risk

assessment and investment strategies. This approach will also help accelerating resource efficiency and circular approaches, while allowing provisioning systems to evolve within sustainable resource use boundaries. Given the presented approach considers time, geography, resource type, and jurisdictional levels, the study provides a framework to contextualize global science-based targets into regional realities.

HIPA 2: Sustainable Resource Management for effective action on climate change, biodiversity, and pollution

Decarbonizing Global Cities with Environment, Health and Biodiversity Co-Benefits: A Land-Use Linked Multi-Sector Provisioning Systems Approach

Status: Approved Terms of Reference are included in Annex 1.

Urban areas account for more than 70% of global GHG emissions and are set to absorb 2.2 billion additional residents by 2050, mostly in Asia and Africa. This workstream demonstrates how circular and resource-efficient solutions across urban provisioning systems - energy, mobility, construction, water, waste, and green infrastructure - can drive decarbonization while delivering multiple co-benefits. It highlights demand-side interventions such as compact urban form, shared mobility, and efficient buildings, alongside supply-side innovations like renewable energy, nature-based solutions, and material circularity. By embedding these strategies in land-use and infrastructure design, cities can simultaneously cut emissions, reduce resource use, improve health, and safeguard biodiversity. The report will assess pathways toward decarbonization through a bottom-up approach in 5 global metropolitan regions [Accra (Ghana), Chennai (India), Iloilo City (Philippines), Shanghai (China) and São Paulo (Brazil). Potentially, Dakar (Senegal) and/or Istanbul (Turkey)] that can also deliver co-benefits to the environment, health, equity and biodiversity.

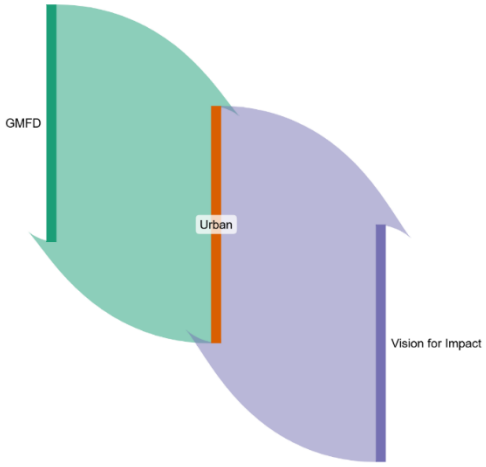


Figure 5: Relationship between 'Urban' and Core Priority Products 2026-2029

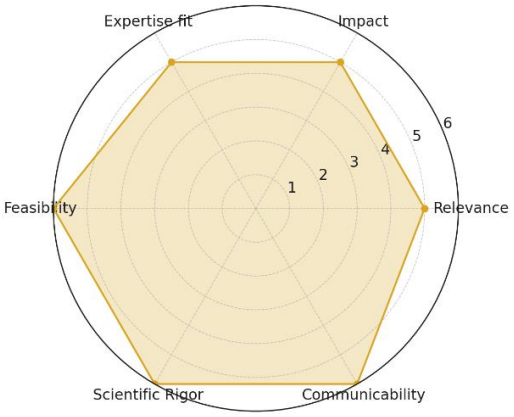


Figure 6: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential: Presently, there are no multi-sector bottom-up models for cities and urban metro regions to develop pathways to decarbonization with multiple co-benefits. Furthermore, there are no systematic models to link decarbonization strategies with multiple co-benefits to

environment, health and biodiversity. The work supports Governance by developing a systems-based framework for urban decarbonization that integrates climate, biodiversity, and health targets. By linking urban design with national and global sustainability goals, it equips policymakers with evidence for integrated governance across scales. The report contributes to impact in Provisioning Systems & Circular Solutions by positioning urban circularity as a level for change, and demonstrating how circularity and efficiency in key urban provisioning systems can reduce GHG emissions, resource demand, and pollution while enhancing well-being and resilience. By focusing on specific cities, it contributes to the Regionalization goal of the IRP, ensuring relevance and scalability across diverse regional realities.

Advancing the Circular Economy in Consumer Electronic Markets

Status: First Draft approved and under Peer Review. Expected launch in 2026.

Consumer electronics are among the fastest-growing and most resource-intensive product categories, driving demand for critical minerals, energy, and plastics. Current linear patterns - short product lifetimes, limited repairability, and premature recycling - result in significant material loss and environmental impacts. This scientific assessment demonstrates how circular solutions can transform the sector by embedding value retention processes (repair, reuse, refurbishment, remanufacturing) across the lifecycle of devices. It highlights the enabling role of product design standards, extended producer responsibility, and business model innovation in extending product lifetimes and closing material loops. By doing so, the assessment provides evidence that circular strategies in electronics can simultaneously reduce resource pressures, lower waste and emissions, and enhance access to essential services worldwide

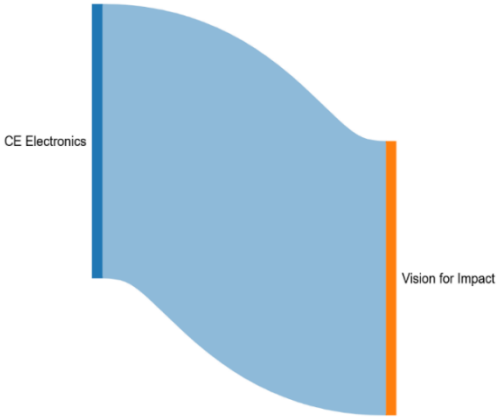


Figure 7: Relationship between 'Consumer Electronics' and Core Priority Products 2026-2029

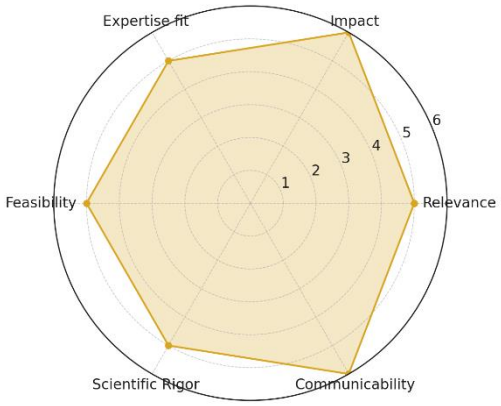


Figure 8: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential: The assessment directly supports the IRP's 2026–2029 Vision for Impact by identifies barriers in product design, trade policy, and business models that hinder value retention processes (repair, reuse, remanufacturing). By mapping these barriers, it provides evidence to guide governance frameworks. By quantifying the economic value lost through

premature recycling and waste, and the benefits of extending product lifetimes, the study provides a case for redirecting capital flows toward circular business models in electronics. Circular strategies in consumer electronics can reduce resource pressures while ensuring access to essential services, especially in the Global South, and case studies, such as those from Ghana, show how informal repair and resale markets contribute to livelihoods and access to technology. By analyzing these practices and their environmental and social trade-offs, the work grounds global circular economy insights in regional and local realities.

HIPA 3: Sustainable Resource Management for effective action on human health, wellbeing, prosperity, and equity

Socio-economic/distributional implications of sustainability transitions

Status: Status: First draft under development. Expected launch in 2026.

This research focusses on socioeconomic and distributional implications of transitions toward more resource-efficient and circular economies. In response to member feedback, the study will be a short, thought provoking and policy relevant piece that can be delivered early in the cycle and help frame how the IRP engages with socioeconomic issues going forward. The work will examine how resource efficiency and circular economy strategies affect jobs, livelihoods, justice, and wellbeing, identifying both opportunities and risks. Key themes include: Employment impacts, justice and equity dimensions, trade-offs and rebound effects, as well as sectoral cases. The output will not attempt to provide a comprehensive global framework but rather deliver concise, policy-relevant insights that inform global debates, highlight where IRP analysis adds unique value, and identify knowledge gaps to guide future assessments.

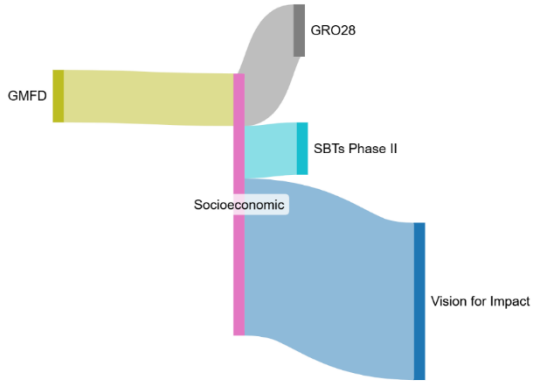


Figure 9: Relationship between 'Socioeconomic Impacts' and Core Priority Products 2026-2029

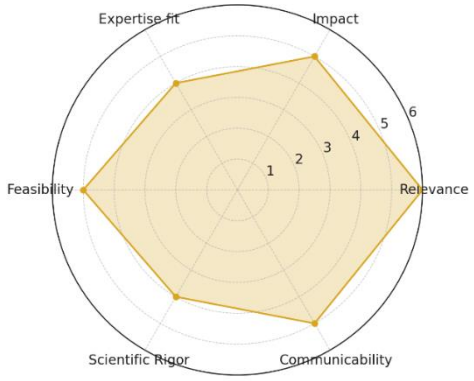


Figure 10: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential: The socioeconomic workstream strengthens the IRP's impact by embedding issues of justice, equity, and livelihoods into the resource agenda. It supports governance by providing evidence on distributional effects of circular economy and efficiency policies, ensuring that equity and fairness are integral to policy design. It connects to finance by highlighting how economic systems and market structures shape inequalities, access to

opportunities, and the financial conditions for just transitions. It advances provisioning systems and circular solutions by assessing how shifts in food, housing, energy, and mobility systems affect employment, skills, and wellbeing, and by clarifying trade-offs such as rebound effects. Finally, it promotes regionalization by drawing attention to diverse socioeconomic realities. Together, these insights ensure that the IRP's vision of sustainable resource management is not only environmentally sound but also socially inclusive.

Agreed Products Under Development

HIPA-1: Current trends and future prospects for global resource Use and Sustainable Resource Management

Global Resources Outlook 2028

Status: TORs are submitted for approval at the 34th Meeting of the IRP.

The Global Resources Outlook 2028 is the IRP's flagship scientific assessment for this Work Programme. It provides the authoritative evidence base on global resource use, human well-being, and environmental sustainability, highlighting the risks of current trajectories and opportunities for transformative change. Key innovations include a focus on the distribution of benefits and impacts of resource use, systematic integration of circularity and resource recovery indicators, and improved analytical frameworks that link drivers of resource demand, environmental pressures, impacts and policy responses in an integrated way.

The report will clarify global trends in resource use and impacts, demonstrate pathways for "dual decoupling" of development from environmental harm, and provide scenario-based insights to 2060 and beyond. It will emphasize provisioning systems as entry points for change, such as food, mobility, energy and the built environment, while reflecting policy priorities including energy transitions, biodiversity protection, and climate action. The report aims to provide clear, material-specific results and messaging.

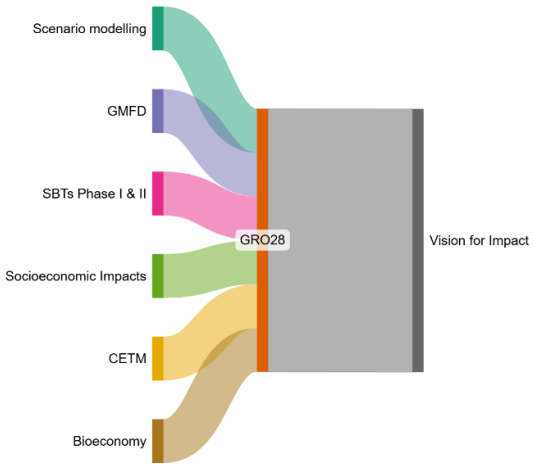


Figure 11: Relationship between GRO28 and Core Priority Products 2026-2029

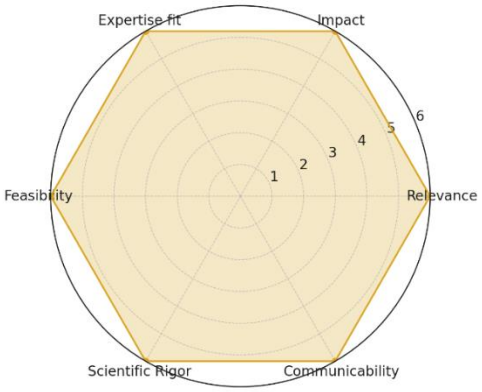


Figure 12: GRO28evaluated against 2026-2029 Criteria for Assessment

Impact Potential:
Concluding with a science-based action agenda, GRO28 advances all four pillars of the IRP's Vision for Impact and positions natural resource management at the centre of strategies for a

just, resilient, and liveable future. GRO28 is expected to inform key global processes including UNEA, UNGA, HLPF, G20, G7, CBD, UNFCCC, UNCCD, and the post-2030 sustainability agenda, among others.

Scenario Modelling (including for GRO28)

Status: TORs are submitted for approval at the 34th Meeting of the IRP.

A workstream designed to deliver the forward-looking evidence base that underpins the GRO28. It will provide robust projections to 2060 on resource use, environmental pressures, and human well-being outcomes, comparing historical trends with an integrated wellbeing and sustainability transition. Using a state-of-the-art multi-model architecture (GTEM, IMAGE, GLOBIOM), complemented by input–output, stock–flow, and life-cycle analysis, the modelling will generate coherent insights across economy, society, and environment, paying particular attention to distributional outcomes and country context.

It will explore the potential for resource efficiency, circular economy, just transitions, sustainable bioeconomy strategies, and climate and biodiversity action to achieve "dual decoupling" - maximizing development while reducing impacts. Results will include scenario projections based on policy packages, and case studies on critical areas such as provisioning systems, energy transitions, and equitable resource distribution. The outputs will be fully integrated into GRO28.

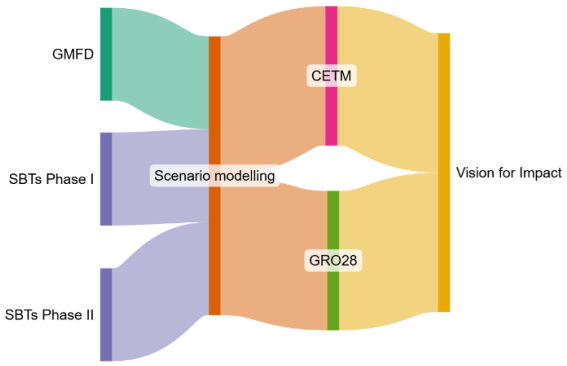


Figure 13: Relationship between Scenario Modelling and Core Priority Products 2026-2029

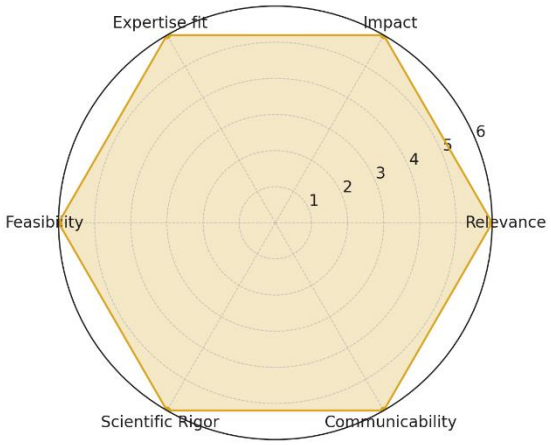


Figure 14: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential:
Scenario modelling contributes to all four pillars of the IRP's Vision for Impact - informing governance through long-term policy insights, supporting finance by assessing economic dimensions of transition pathways, guiding provisioning systems and circular solutions via systems analysis, and enabling regionalization through differentiated assumptions and outputs. In addition to GRO28, it supports broader engagement with global processes such as UNEA, UNFCCC, CBD, UNCCD, and the post-2030 sustainability agenda.

Agreed for Impact (2026-2029)(new)

HIPA-1: Current trends and future prospects for global resource Use and Sustainable Resource Management

Science Based Targets Phase II

Status: New proposal; Steering Committee members may wish to consider a possible start date in 2026 for a possible launch by 2028 or 2029.

Building on the IRP's Rapid Study on Science-Based Targets (SBTs) Phase I, which established the conceptual foundations for a multidimensional target-setting framework grounded in the Drivers–Pressures–State–Impact–Response (DPSIR) model, Phase II will operationalize and test this framework across major categories of material resources. The objective is to translate scientific evidence on planetary and social boundaries into actionable, quantifiable thresholds that can guide national, regional, and global policymaking.

Through this work, the IRP aims to:

- Enable the integration of environmental and equity considerations across provisioning systems and circular solutions;
- Support coherence across international target-setting processes, including climate, biodiversity, and pollution frameworks; and
- Strengthen regionalization by offering adaptable methodologies that countries can tailor to their specific contexts and data capacities.

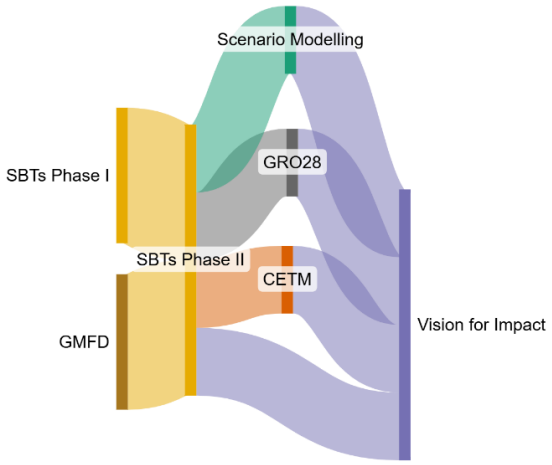


Figure 15: Relationship between SBTs Phase II and Core Priority Products 2026-2029

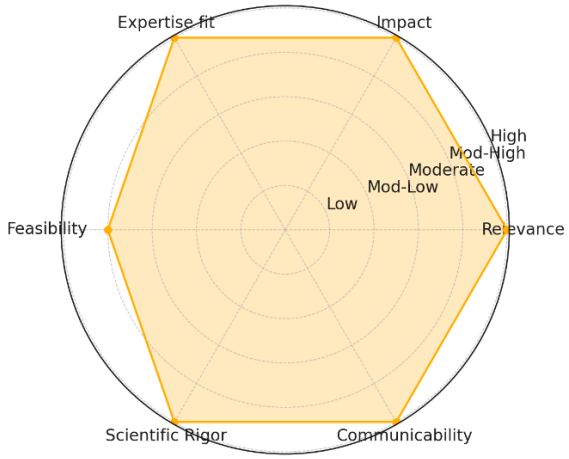


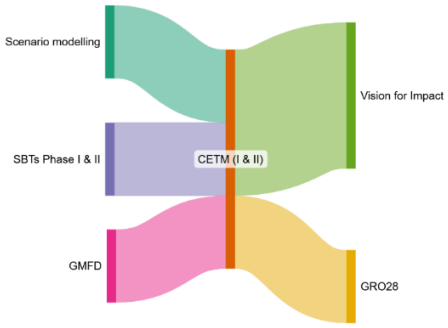
Figure 16: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential:
Phase II directly supports the IRP's 2026–2029 *Vision for Impact* by providing measurable, policy-relevant benchmarks for sustainable resource use. The work will contribute to improved governance and planning by identifying science-based limits and thresholds for

resource extraction and consumption, and by linking them to wellbeing, equity, and economic outcomes.

HIPA 2: Sustainable Resource Management for effective action on climate change, biodiversity, and pollution

Critical Transition Minerals for Energy and Digitalization (CTM)(Phase I and Phase II)	
Status: New proposal; Steering Committee members may wish to consider a possible start date of the rapid Study in 2026 for a possible launch by 2027; and the start of a Scientific Assessment in 2027 for a Possible Launch in 2029.	
Their extraction, trade, and use of Critical Transition Minerals (CTMs) such as lithium, cobalt, nickel, and rare earths underpin the shift to renewable energy, electrified mobility, and digitalization, but also raise profound challenges for sustainability, equity, and governance. This research seeks to inform one of the most urgent and politically salient resource challenges of the coming decades: ensuring the sustainable, fair, and efficient use of critical transition minerals. Despite their strategic importance, there is still no shared scientific framework that addresses how they can be managed fairly, efficiently, and within earth's carrying capacity. This is a clear global priority – highlighted by the UN Secretary-General's Panel on CETMs, by UNEA-6's resolution on environmental aspects of minerals and metals, and by growing geopolitical debates around resource security. The IRP is uniquely placed to bring a systems perspective going beyond supply-demand projections to inform key questions around the potential gains from material efficiency and circularity strategies across CTM value chains, the technical and economic feasibility of such strategies, and their impacts on emissions, biodiversity loss, and pollution. What strategies support added value in resource-rich countries, ensuring fair value creation and development benefits? From a policy perspective, what instruments, incentives and standards can be effective at stages of the value chain, what are risks and trade-offs, and how can we chart the way towards sustainable pathways.	Impact Potential: The proposed work responds to the material foundations of global energy, mobility and digital transitions. It contributes directly to the IRP's Vision for Impact by potentially advancing governance through evidence on policy instruments and target-setting, by aligning finance with sustainable resource use through analysis of value capture and investment incentives, and by embedding circular solutions into provisioning systems for energy, mobility, and digitalization. It also strengthens regionalization by highlighting pathways for producer countries to benefit from inclusive business models and equitable allocation. A two phased approach of first, a rapid study will deliver near-term insights to inform urgent global debates and the SG Panel's follow-up, while consultations and scoping establish the foundations for a robust full scientific assessment. This sequencing allows the IRP to shape fast-moving discussions without rushing into premature modelling, ensuring later analysis is comprehensive, credible, and policy-relevant.



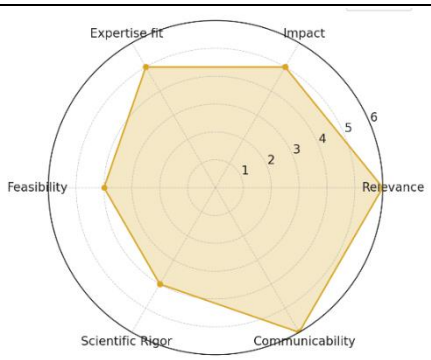
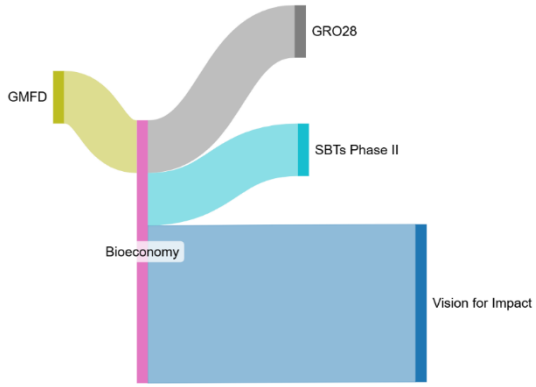


Figure 17: Relationship between 'Transition Mineral' and Core Priority Products 2026-2029 (left);
Figure 18: Evaluated against 2026-2029 Criteria for Assessment (right)

Resource Efficient and Circular Economy Strategies for a Sustainable Bioeconomy	
Status: New proposal; Steering Committee members may wish to consider a possible start for a Scientific Assessment in early 2026, with potential launch date in late 2027.	
The bioeconomy is fast becoming a cornerstone of global sustainability strategies, with governments, businesses, and regions turning to biomass and bio-based innovation to deliver food, feed, fibre, fuel, biomaterials, biotechnology, and ecosystem services. Yet, rising demand for biomass is intensifying pressures on land, biodiversity, water, and climate, while social and equity dimensions remain poorly addressed. No integrated scientific framework yet demonstrates how the bioeconomy can be made resource-efficient, circular, and equitable across its various purposes while supporting climate, biodiversity, and development goals. The IRP is well placed to respond by applying its systems thinking, life-cycle analysis, and material flow expertise to assess the resource implications of bio-based transitions across provisioning systems – food, energy, mobility, and built environment – and by positioning the bioeconomy as a cross-sectoral transformation rather than a single resource stream. This work would focus on questions that remain unanswered despite growing policy attention: which circular and efficiency strategies (such as cascading use, nutrient recycling, waste valorization, and bio-based business models) deliver the greatest sustainability and equity gains? How can trade-offs between food security, biodiversity, and climate be managed, and how should governance linkages with agriculture, trade, and SDG frameworks be strengthened? How can inclusive bioeconomy models embed Indigenous knowledge, gender equity, and rural livelihoods, ensuring producer countries and local communities benefit? What role can finance and	Impact Potential: The research contributes to resource-efficient and circular solutions by identifying opportunities to reduce land, water, and climate pressures through more sustainable use of bio-based materials; strengthens resource governance by informing policy choices around trade-offs in biomass use and land allocation, and by clarifying environmental risks tied to unchecked bioeconomy expansion. If scoped with regional differentiation in mind, it could also support regionalization, offering insights tailored to country contexts where biomass-based strategies are central to development planning. Given the pace of international discussions and strong policy demand, the work will seek to deliver a scientific assessment by 2027. An intensive scoping study will inform Terms of Reference development for the full scientific assessment,

innovation – from blended finance to carbon markets and public–private partnerships – play in scaling sustainable pathways? And what monitoring frameworks and indicators are needed to track environmental, social, and economic outcomes?	which may include scenario modelling, governance analysis, regionally differentiated pathways, and the development of monitoring frameworks.



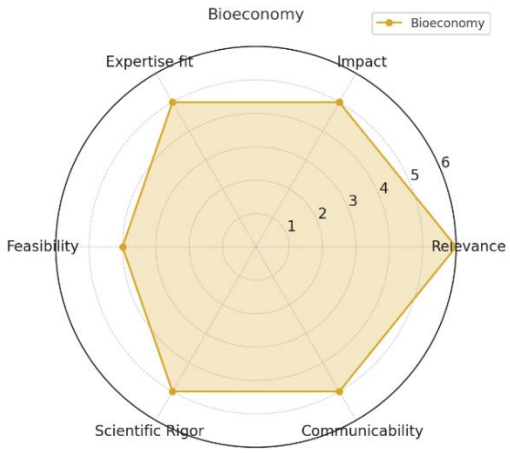


Figure 19: Relationship between 'Transition Mineral' and Core Priority Products 2026-2029 (left);
Figure 20: Evaluated against 2026-2029 Criteria for Assessment (right)

HIPA 4: Enabling sustainability transitions

Financing, Investment and Trade for Sustainable Resource Use
Status: New proposal – Steering Committee may wish to consider a possible start in 2028, leading to a Rapid Study launch in 2029.

Mobilizing finance is essential to scale up sustainable resource use, yet resource efficiency and circularity remain peripheral in most financial agendas. Where enabling policy instruments exist – such as standards, pricing, disclosure, and procurement – investment can move rapidly.

However, externalities remain unpriced and incentives fragmented. Without a systemic understanding of how financing and trade interact with market transformation, global action risks being partial or misaligned.

This work would position the IRP as a leading voice on the finance–resource–trade nexus, complementing ongoing climate and nature finance initiatives. It would assess how financial systems and trade structures shape global resource use, examining fiscal incentives, capital allocation, and risk frameworks that either reinforce or can redirect investment towards sustainable and circular solutions. The assessment could also consider equity implications for producer countries, SMEs, and developing economies engaged in global value chains.

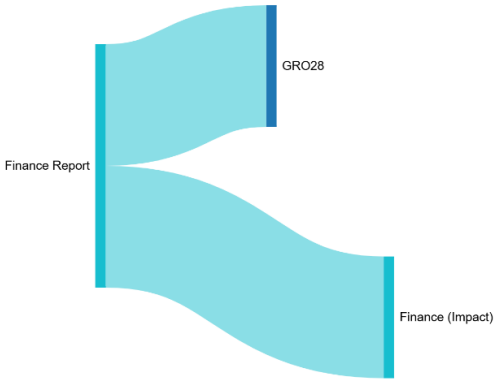


Figure 21: Relationship between Financing/Trade and Core Priority Products 2026-2029

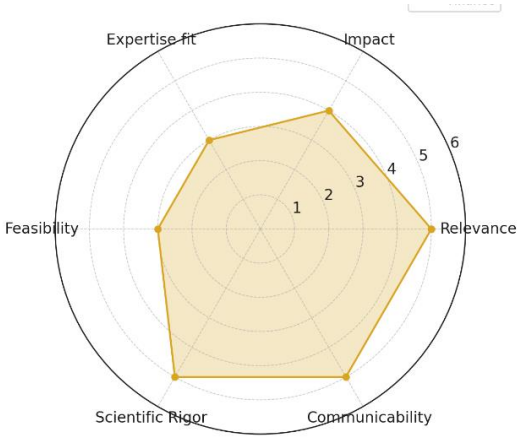


Figure 22: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential:
This workstream addresses one of the most powerful levers for systemic change – aligning financial and trade flows with sustainable resource management. It supports governance by clarifying how fiscal and market-based measures create enabling environments for transitions; informs finance by identifying reforms to public budgets and private investment frameworks; and advances circular and provisioning systems by mapping where finance and trade can accelerate innovation and market uptake.

POSSIBLE PRODUCTS

HIPA-1: Current trends and future prospects for global resource Use and Sustainable Resource Management

Environmental Impacts Dataset

Status: Possible Product. Within projected available resources (based on historical Steering Committee contributions) the IRP may be able to accommodate a total of USD 300,000 on Possible Products. The IRP Steering Committee will guide selection of priorities among possible products, or newly proposed research over the course of 2026-2029 work programme and based on the agreed assessment criteria..

Much like the GMFD, the Environmental Impacts Database is not a standalone product, but a backbone infrastructure - integral to ensuring scientific consistency, comparability, and analytical depth across the IRP's 2026–2029 Work Programme. The initiative supports governance by strengthening the global data infrastructure on environmental pressures from resource use; enhances regionalization by enabling finer-scale and country-level assessments; informs provisioning systems and circular solutions by linking impacts of material flows across systems and sectors; and supports finance by identifying where value creation and environmental burdens intersect.

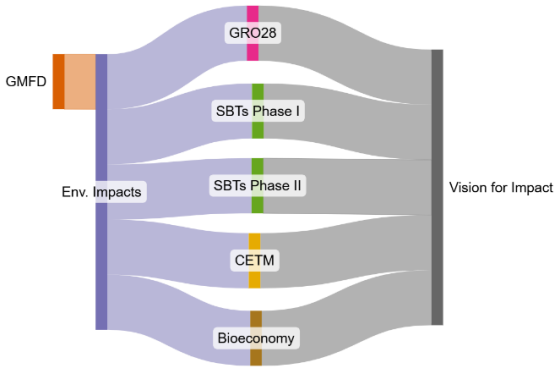


Figure 23: Relationship between Environmental Impacts Dataset and Core Priority Products 2026-2029

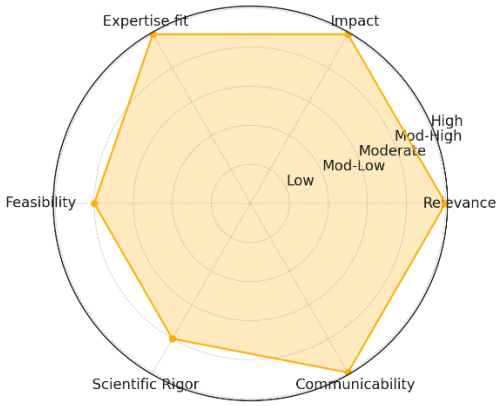


Figure 24: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential:
Much like the GMFD, the Environmental Impacts Database is not a standalone product, but a backbone infrastructure - integral to ensuring scientific consistency, comparability, and analytical depth across the IRP's 2026–2029 Work Programme. The initiative supports governance by strengthening the global data infrastructure on environmental pressures from

resource use; enhances regionalization by enabling finer-scale and country-level assessments; informs provisioning systems and circular solutions by linking impacts of material flows across systems and sectors; and supports finance by identifying where value creation and environmental burdens intersect.

Online Capacity Development Tools and Regionalization

Status: Possible Product. Within projected available resources (based on historical Steering Committee contributions) the IRP may be able to accommodate a total of USD 300,000 on Possible Products. The IRP Steering Committee will guide selection of priorities among possible products, or newly proposed research over the course of 2026-2029 work programme and based on the agreed assessment criteria.

Much like the GMFD, the Environmental Impacts Database is not a standalone product, but a backbone infrastructure - integral to ensuring scientific consistency, comparability, and analytical depth across the IRP's 2026–2029 Work Programme. The initiative supports governance by strengthening the global data infrastructure on environmental pressures from resource use; enhances regionalization by enabling finer-scale and country-level assessments; informs provisioning systems and circular solutions by linking impacts of material flows across systems and sectors; and supports finance by identifying where value creation and environmental burdens intersect.

Questions of scope, complementarity, and partnership – especially considering the need for strong collaboration with partners including UNEP, target audiences, and the risks of developing tools in isolation – should be clarified before proceeding.

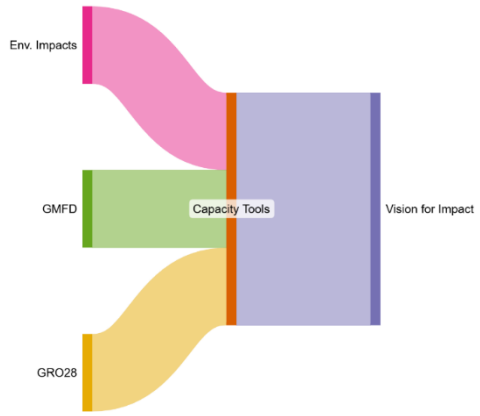


Figure 25: Relationship between Online Capacity Development and regionalization Tools and Core Priority Products 2026-2029

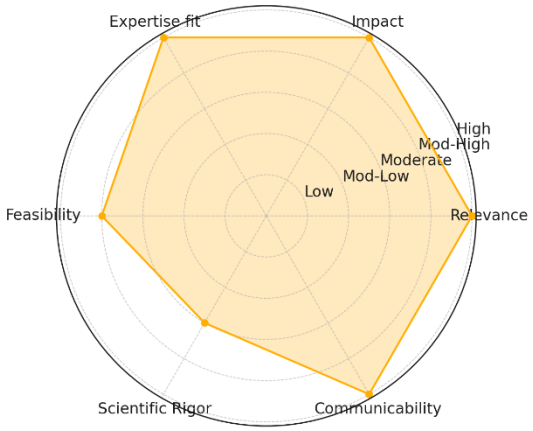


Figure 26: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential:
Online capacity development tools contribute directly to the IRP's Vision for Impact. They advance governance by institutionalizing open-access infrastructures for resource data, promote regionalization by enhancing the granularity and uptake of IRP outputs, and support provisioning systems and circular solutions by enabling actors to assess impacts across food, housing, mobility, and energy systems related to their context. By providing user-friendly, scalable platforms, this workstream enhances policy uptake and positions IRP knowledge as an indispensable resource for aligning global insights with national realities.

HIPA 4: Enabling sustainability transitions

Options for Coordinated Resource Governance at Multiple Scales

Status: Possible Product. Within projected available resources (based on historical Steering Committee contributions) the IRP may be able to accommodate a total of USD 300,000 on Possible Products. The IRP Steering Committee will guide selection of priorities among possible products, or newly proposed research over the course of 2026-2029 work programme and based on the agreed assessment criteria.

Despite the centrality of resources to climate, biodiversity, and equity outcomes, institutional responses remain fragmented. This rapid study could examine potential mechanisms for strengthening governance of natural resources across multiple scales – from global coordination to regional arrangements and national frameworks. It could respond to the governance gap identified in *GRO24* and subsequent IRP work by reviewing and comparing emerging models – such as international agencies, regional platforms, voluntary coalitions, or science-based target approaches – to propose a set of options that might enhance transparency, accountability, and equitable access to resources.

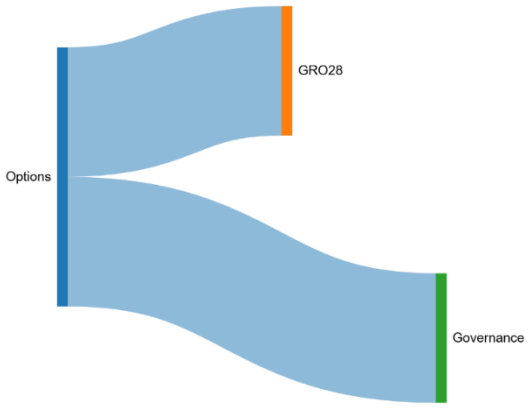


Figure 27: Relationship between Options for Coordinated Governance and Core Priority Products 2026-2029 (top); Evaluated against 2026-2029 Criteria for Assessment (bottom)

Impact Potential: **Impact Potential**: The study could produce a concise options paper to inform policymakers about different pathways for institutional reform. It could serve as a key input to the Global Resources Outlook 2028 report, while also linking to ongoing IRP work on Science-Based Targets, helping to ensure consistency and complementarity.

Enabling Policy Instruments for Circular Economy Transitions

Status: Possible Product. Within projected available resources (based on historical Steering Committee contributions) the IRP may be able to accommodate a total of USD 300,000 on Possible Products. The IRP Steering Committee will guide selection of priorities among possible products, or newly proposed research over the course of 2026-2029 work programme and based on the agreed assessment criteria.

Circular economy strategies are proliferating, yet large-scale transitions remain rare. Scenario models, such as those developed for the Global Resources Outlook, indicate the scale of change needed – but they do not specify which policy mechanisms can deliver these outcomes. The unique value of this study lies in bridging IRP's scenario modelling and provisioning systems analysis with real-world policy performance.

The study could address urgent policy questions: Which combinations of fiscal, regulatory, and trade measures have been most effective in enabling circular economy transitions and reducing resource use? How can enabling environments for CE be adapted across provisioning systems like food, housing, mobility, and energy? What lessons emerge from regional and national contexts, especially in the Global South, where CE strategies are being mainstreamed but are under-assessed?

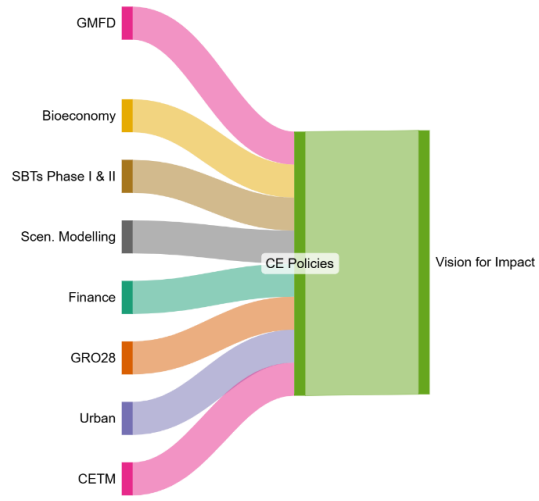


Figure 28: Relationship between Enabling Policy Instruments for CE Transitions and Core Priority Products 2026-2029

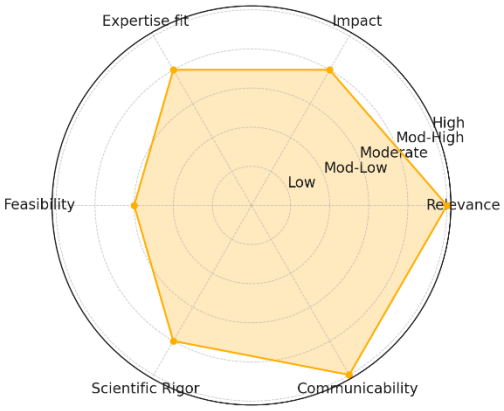


Figure 29: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential: **Impact Potential**: This rapid study could fill a critical evidence gap by showing not just what must change, but how policy can drive it. It would directly support IRP's 2026–2029 priorities on governance and circular solutions, strengthen the policy relevance of GRO28, and position the IRP as the go-to source for linking resource modelling, policy effectiveness, and equitable transition pathways. To avoid overlap, it should be carefully scoped.

Resources and Conflicts

Status: Possible Product. Within projected available resources (based on historical Steering Committee contributions) the IRP may be able to accommodate a total of USD 300,000 on Possible Products. The IRP Steering Committee will guide selection of priorities among possible products, or newly proposed research over the course of 2026-2029 work programme and based on the agreed assessment criteria.

Conflicts are on the rise globally, and many have a clear link to resources – from competition over land and water, to struggles over critical minerals and energy supplies. At the same time, wars and instability devastate resource systems: infrastructure is destroyed, landscapes degraded, trade disrupted, and recovery drives surges in demand for construction materials and fuel. These dynamics show that resources are not only part of the problem, but also a cornerstone of lasting peace and resilience.

The IRP brings a distinct contribution by focusing on the resource transitions that follow conflict – decisions on rebuilding food, housing, energy, and mobility systems either lock in unsustainable patterns or open pathways to circular, low-impact solutions. This systems perspective is largely absent from current peace and security debates, which tend to treat resources only as a source of conflict rather than as an enabler of recovery.

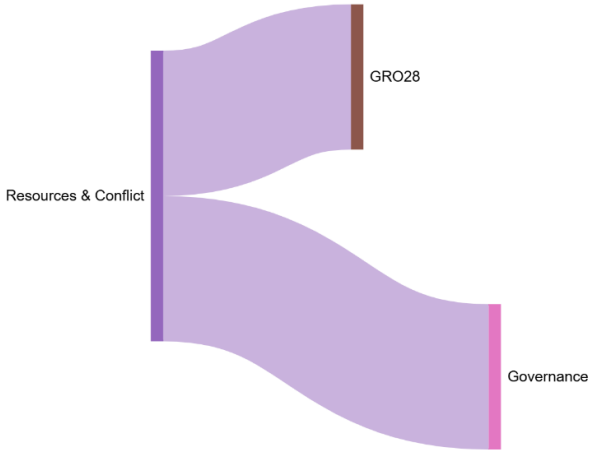


Figure 30: Relationship between resources 7 Conflicts and Core Priority Products 2026-2029

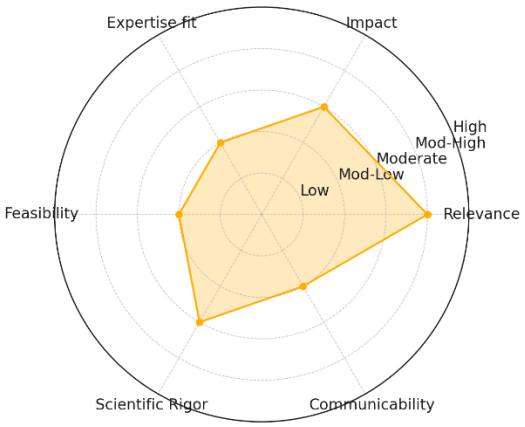


Figure 31: Evaluated against 2026-2029 Criteria for Assessment

Impact Potential: **Impact Potential**: The study could produce a concise options paper to inform policymakers about different pathways for institutional reform. It could serve as a key input to the Global Resources Outlook 2028 report, while also linking to ongoing IRP work on Science-Based Targets, helping to ensure consistency and complementarity.