# Annex 1

Approved Terms of Reference for 2022-2025

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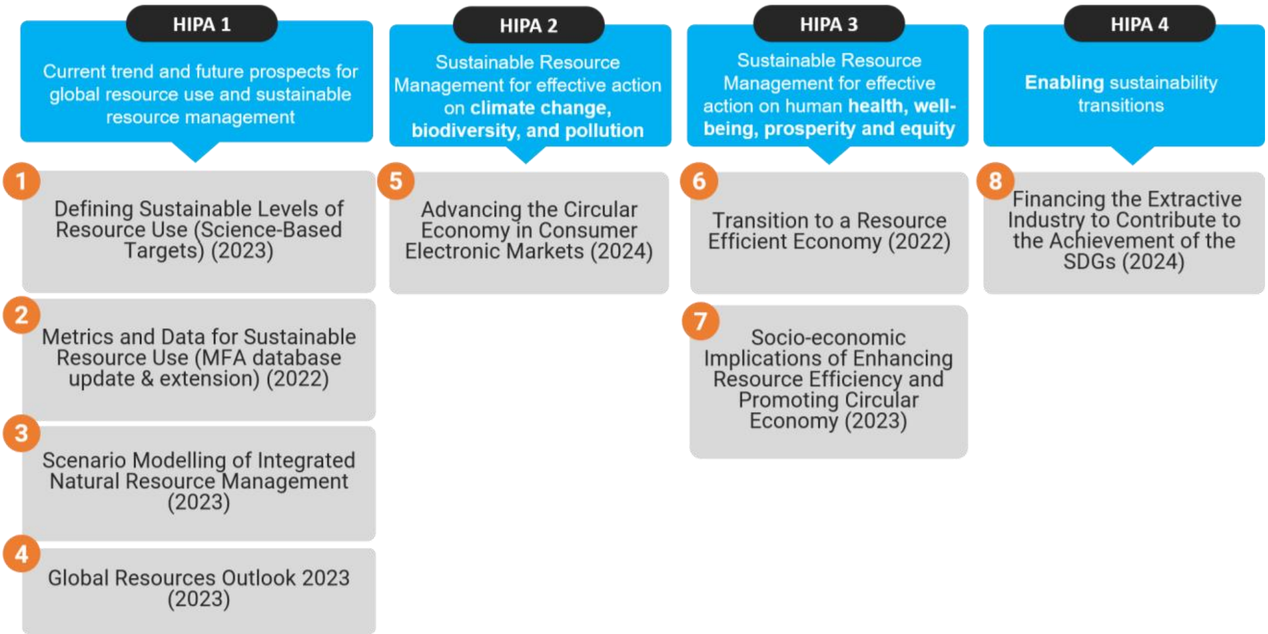
## APPROVED TERMS OF REFERENCE

The following Terms of Reference have been approved by the IRP Steering Committee and Panel and will be carried over to the 2022-2025 IRP Work Programme:



# Approved ToRs under HIPA1: Current trends and future prospects for global resource use and sustainable resource management

## 1. Defining Sustainable Levels of Resource Use (Science-Based Targets)[1]

**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 IRP 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

[1] These Terms of Reference were approved on 6 August 2020. The USA agreed to approve the following activities of this workstream: map the existing landscape of science-based targets; perform a gap analysis of existing science-based targets; create a proposal for principles and criteria for potential new science-based targets; and review the literature of quantitative proposals of resource-relevant science-based targets, including to inform the scenario modeling workstream, as appropriate.

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.

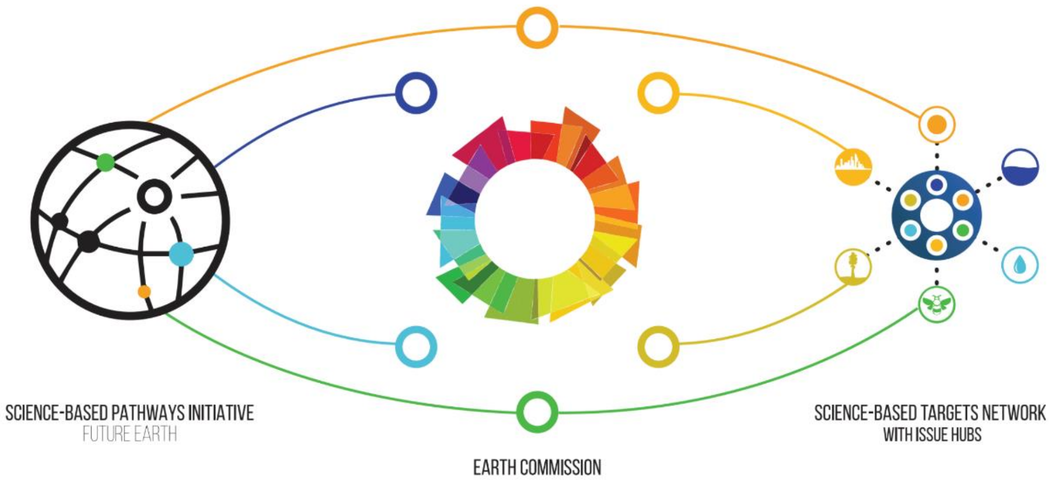



***Figure 1:*** *The Earth Commission is set up to inform two parallel processes. The work of the Science-based pathways initiative (SBPI) will provide cross-scale assessments by the science community supported by Future Earth. Private sector and city level action-oriented work will be "informed" by 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.

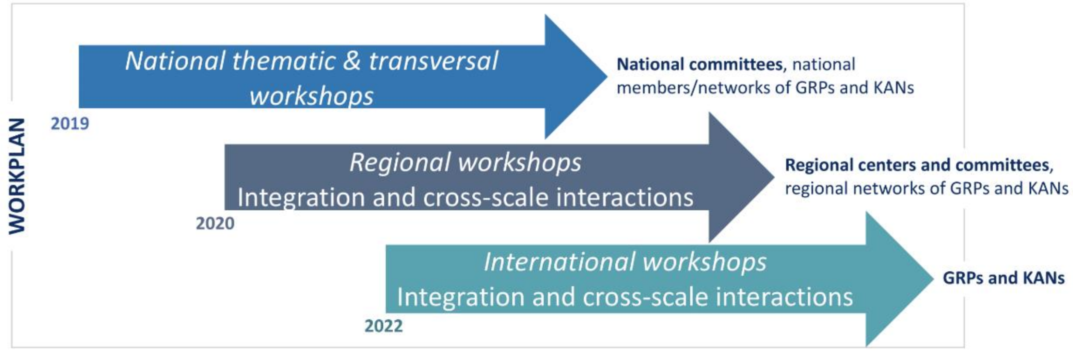



Image: Workplan for the Science-Based Pathways for Sustainability Initiative (Future Earth), with on the right envisioned roles for each entity of the Future Earth community: Global Research Projects (GRPs), Knowledge-Action Networks (KANs), National committees and Regional Centers and Committees.

***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** **Conclusion**

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)

1. The SBTN has recruited 800+ global companies and cities who set Zero Net GHG emission targets
2. The scientific underpinning of target setting is still to be improved and the set of target dimensions is bound to be expanded
3. The SBTN is fully operational and has embarked on processes to improve its methodologies (e.g. GHG accounting for NBS)
4. 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[2] (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

[2] https://sciencebasedtargets.org/

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.

## 2. 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.

## 3. 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.

**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)[3] or the SDG index[4] 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.

[3] https://sustainability.sciencesconf.org/data/pages/E1_Liano_Ekins_1.pdf
[4] 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).

## 4. SCOPE

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.

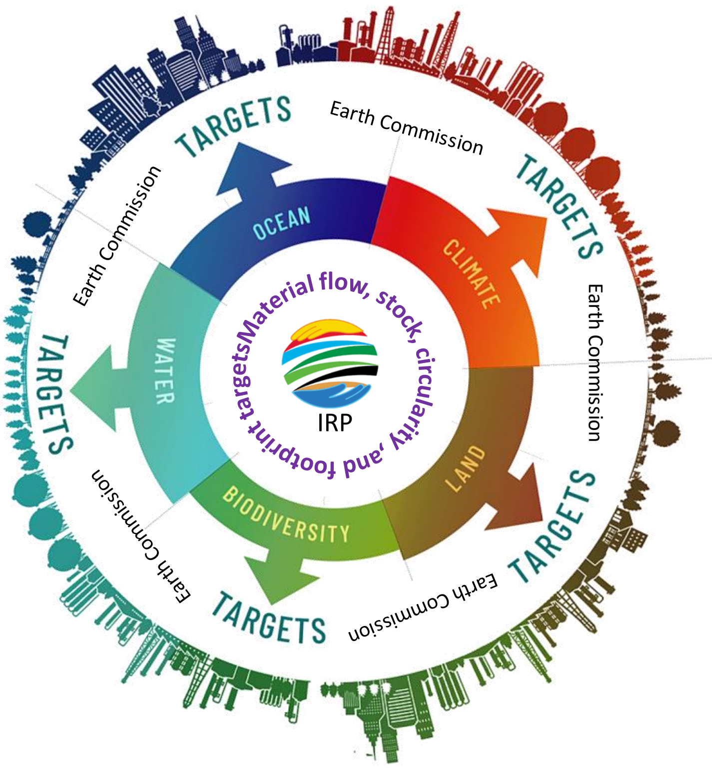


***Table 1:*** *Preliminary mapping of SDG indicators by resource domain. SDG indicators potentially qualifying as environmental impact target formulations are identified together with potential target quantification. Last column identifies SDG indicators which would allow for the tracking of progress 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**<br>***Covered by IRP Assessment**<br>****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

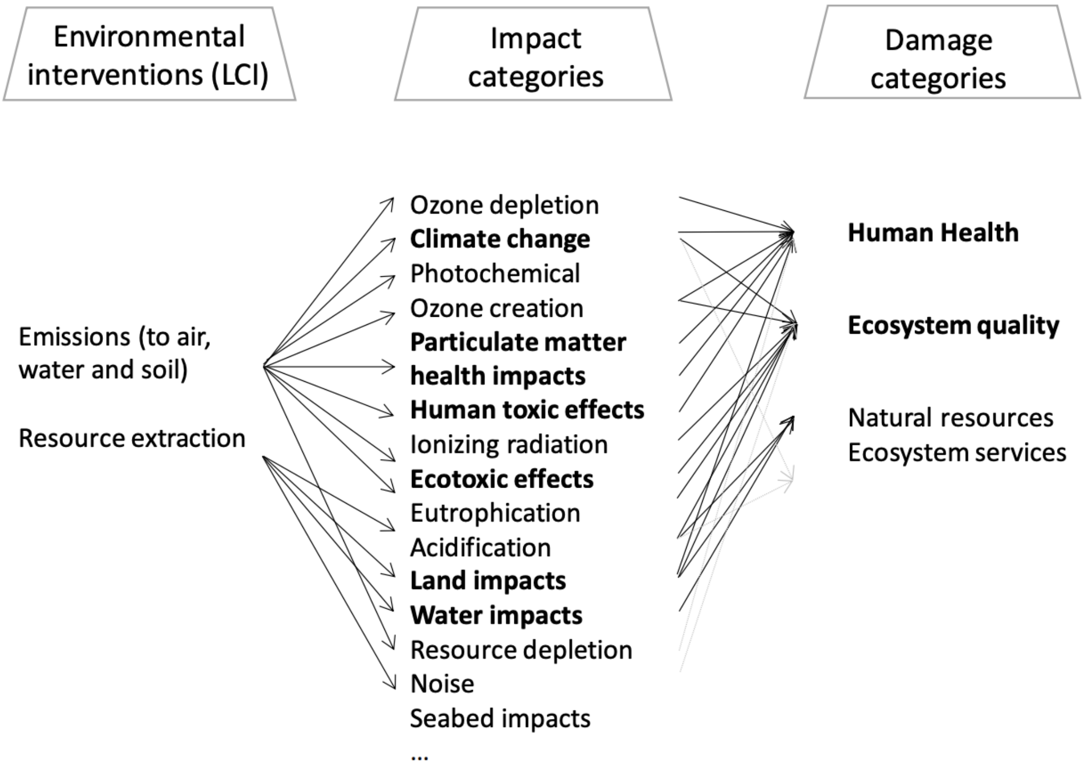



*Figure A.3: Excerpt of framework of Life Cycle Impact Assessment. All impact categories quantified in this report are printed in bold. (figure adapted from UNEP-SETAC 2016)* (UNEP SETAC 2016)

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 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.

## 5. 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.

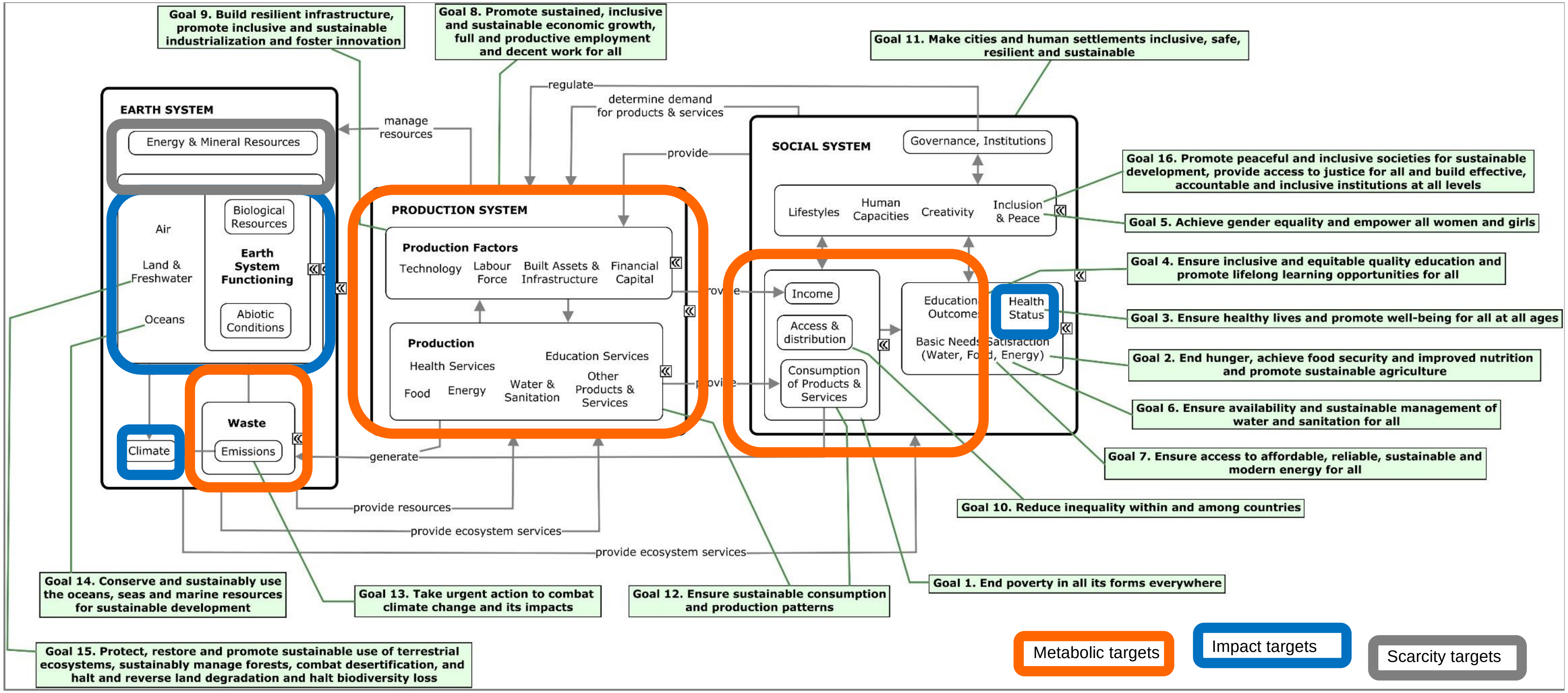



***Figure 4:*** *SDGs (and its targets) are written from many different perspectives, representing diverse fields of science and policy. Earlier attempts to conceptualize interactions between SDGs do it at the level of goals or targets ignoring the underlying dynamics, that result in linkages representing 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

## 6. BUDGET

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

## 7. 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.

## 8. 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.

## 9. 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.

## 10. 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?

## 11. 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.

## 12. 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.

## 13. 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.

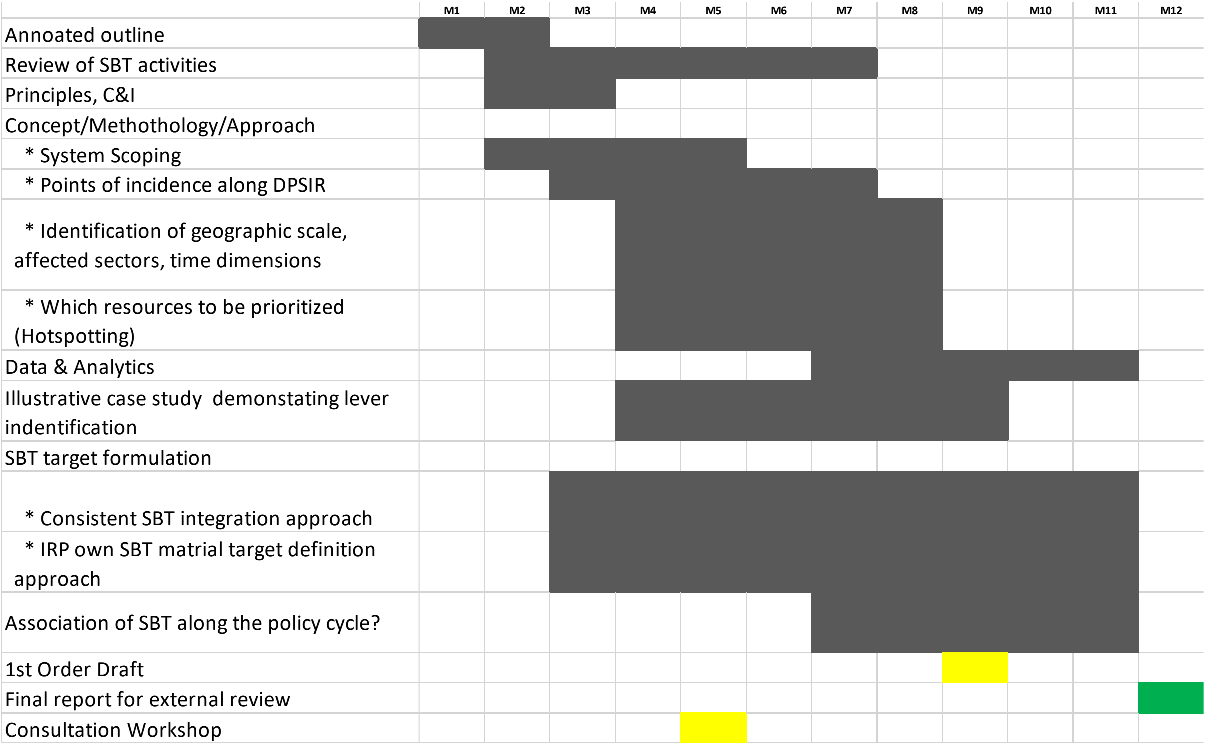
## 14. PROPOSED LEAD AUTHORS

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

## 15. 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.

## 16. WORK PLAN INCLUDING TIMELINE



# 2. Metrics and Data for Sustainable Resource Use (MFA database update & extension)

**Terms of Reference**[5]

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Revised version to include feedback received from panel and steering group members of 5 April 2019.

## 1. INTRODUCTION

The IRP planning process has identified a work stream for *Metrics and Data for Sustainable Resource Use* as part of the High Impact Priority Area 1 *Current trends and future prospects for global resource use and sustainable resource management* of the 2018 – 2021 IRP work program. This work stream was approved by the steering group during the regular IRP meeting in Lima, Peru in 2017. The core of the work stream is the regular updating, methodological and technical improvement and extension of the Global Material Flow and Resource Productivity Database. Such an update should occur on a yearly basis over the next 5-years to allow countries to report progress for SDG targets 8.4 and 12.2 and in case of a database extension for waste flows also target 12.5. In doing so, the IRP is addressing an information gap that will in the future be filled by countries and their National Statistical Offices. Over time the dataset may pivot towards becoming a data repository and serve the purpose of quality assurance, comparison and benchmarking. The dataset is also an infrastructure for the IRP's policy research more generally and supports delivery of the regular report *Global Assessment of Natural Resource Use and Management*. The work stream is planned and budgeted for the next three years 2019-21 and structure in a modular way so as to allow to identify priorities.

## 2. Purpose, scope, structure and perspective

### 2.1. Purpose

The Sustainable Development Goals represent an ambitious aspiration of 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 central to the SDGs that those achievements in prosperity and human wellbeing need to rest upon the sound management of natural resources and will be achieved through ambitious policies to decouple economic activity from environmental pressures and impacts.

This is best represented in SDG 8 and SDG 12 which address the scale and allocation of natural resources – i.e. the physical economy – across all stages of the life cycle of resource use from extraction to disposal. The empirical basis for monitoring SDG 8.4 and SDGs 12.2 and 12.5 is developed through national material flow accounts that are compatible with the system of national accounts and the Systems of Integrated Environmental and Economic Accounts (SEEA).

The methodological guidance for national material flow accounts has been developed by the European Statistical Office (EUROSTAT 2013, 2016, 2018) and the political context and interpretation of indicators was delivered by the Organisation for Economic Cooperation and Development (OECD 2008) and the European Environmental Agency (EEA). This year UN Environment has commenced a project for a global material flow accounting manual which is now under review (UNEP 2018).

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[5] Terms of reference approved on 12th April 2019

The European Commission has spearheaded a process of reporting of material flow data as part of the official statistics in all European Community member states and also through the European Statistical Offices. Japan is also using material flow data and indicators for reporting in the context of the Sound Material Cycle Society high level policy framework.

In addition, many countries have started their voluntary reporting for progress against SDG goals and targets using the indicators proposed by the Inter Agency Expert Group. They include indicators for resource efficiency of production and consumption and for the sustainable management of natural resources. UNEP has an important function in supporting national statistical offices to expand the institutional and technical capabilities of National Statistical Offices for reporting material flows in their respective countries in the context of the environmentally focussed SDG's.

*Box 1 Global Sustainable Development Goal Indicators*

8.4.1 Material footprint, material footprint per capita, and material footprint per GDP

8.4.2 Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP

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, tonnes of material recycled

While some countries are leading in reporting resource efficiency and per-capita resource use based on their national material flow accounts, many other countries have not yet developed such datasets. For such countries the IRP online material flow and resource productivity database provides information that is not yet available and hence fills a knowledge gap. This is commensurate with the remit of UN Environment to provide technical support to countries, especially to developing nations in Africa, Asia and the Pacific and Latin America and the Caribbean.

## 2.2. Scope and objectives

The proposed study has three main objectives which are focussed on the updating and on extension of the current version of the Global Material Flow and Resource Productivity database and services that are necessary to support the database access and user community.

a) **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 and will also extend the database by adding information for the output side, which will include all components of outflows which allow to create a comprehensive material balance. The outflows include emissions to air, emissions to water, solid waste landfilled, and the dissipate use and loss of products. The data will provide details on the composition of waste flows and emissions, based on integrating the most applicable international data sets available. 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, subject to data availability. Emissions accounts will include the major greenhouse gases (carbon dioxide, methane and nitrous oxides), and also available data on major, monitored air pollutants (such as sulphur dioxide and particulate matter). It will also include the calculation of balancing items on the input and output side of the accounts, and establish

individual national waste potentials, and high-level net additions to stocks accounts based on the structure of material flows and modelled retention times of different materials in the economy. The waste potential will complement the waste accounts based on directly reported data, which is known to be often of poor quality. Methodological modifications and improvements will be undertaken in consultation with other initiatives such as the UN Statistical Division (UNSD) and the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA), among others.

Data will be arranged in such way that it can be used for subsequent analysis for establishing environmental impacts of resource use using the standard approach for life cycle analysis of the UN Life Cycle Analysis Initiative and for input-output analysis for establishing material footprint datasets and indicators. A close concordance with the material flow analysis (MFA) categories displayed by data providers, such as EUROSTAT, will be sought.

**b) Update and extension of the footprint accounts of the global database:**

The proposed activity will provide yearly updates for the footprint accounts of the global database. The updating will involve creating a new global multi-regional input-output (MRIO) table utilizing the global MRIO laboratory (Lenzen et al. 2017). In the course of the study we will create the world's largest supply and use table for the global economy including 150 countries and around 90 sectors. This new table will be tailored for the purpose of the IRP material footprint analysis and will capture major pathways of bulk resources through the global inter industry matrix. We will also extend the current time series that starts in 1990 back to 1970 to match the coverage of the direct accounts. The project may also involve extending the footprint accounts by additional footprints in areas where the global virtual MRIO laboratory has established satellite accounts which includes energy, greenhouse gas emissions, water and land. One important task of the MRIO work at the IRP will be to consult with other organisations that aim for harmonisation of demand-based material flow accounts, including but not limited to the OECD.

All data sources for direct material flow accounts, material footprint accounts and data assembly strategies will be summarised in a comprehensive meta-dataset.

**c) Data integration, reporting and online dataset:**

The IRP database has been made available online in March 2018 and requires, to be fully functional, the servicing of the download function and improvements to the general user interface. More complex data requirements require additional efforts to compile tailored data sets.

The global database has, so far, not integrated any national material flow data which is an important and necessary next step which requires ensuring that methodologies are compatible with the global standard and data quality is sufficient for data integration. Integrating data that is reported by national statistical offices is becoming more important as countries are increasing the capacity to report MFA data and the character of the database will also change to become a repository of international data at some point comparable to other international databases. The integration of national material flow accounts into the IRP database is a complex issue, and will require a stepwise process with close collaboration with individual reporters. The necessary steps will include:

- Comparison of nationally compiled databases to the corresponding IRP data at a level of medium disaggregation to identify major differences, then tracing the causes of divergence. It is expected that the national data sets, based on official national statistics and having the benefit of local knowledge, will provide the most robust data. This assumption, however, needs to be tested and is expected to vary according to the technical capability of the individual national statistical offices. This process should positively impact the data quality of national datasets.
- Where the coverage of the IRP dataset extends beyond the availability of data assembled by national statistical offices, an effort will be made to infill missing data using various, transparent strategies.
- Methodological differences or differences in base data sources need to be documented in metadata to allow users to assess the degree to which datasets are comparable. As global accounting capability grows these differences in methodology, data sources and MFA results are expected to get smaller over time.
- The integration of the EU dataset compiled by national statistical offices in EU countries and complied by EUROSTAT will be used as a test case for the methodological issues that may arise and will be undertaken in close collaboration with EUROSTAT.

Another important aspect is reporting for the Global Resources Outlook which includes tailored data analysis and generation of figures, tables and text.

### 2.3. Structure and work plan

These terms of reference are for a three-year research program commensurate with the High-Level Impact Area 1 objectives and are structured into a set of activities that cover the three objectives outlined above comprehensively.

- **Task 1** Yearly updates of the global domestic extraction data set based on international data sources and reporting for around 60 material extraction categories and four aggregate categories for every country, seven world regions and the world (and other aggregations as required).
- **Task 2** Yearly updates of the global trade of materials dataset based on international data sources and reporting for around 60 material categories for every country, seven world regions and the world (and other aggregations as required).
- **Task 3** Extension of the global material flow dataset by output data on waste and emissions and assessment of net additions to stock and waste potential based on national and international data sources and reporting on waste and emission data and other output categories for every country, seven world regions and the world (and other aggregations as required).
- **Task 4** Yearly updates of the material footprint of final demand dataset based on international data and the EORA global and multiregional Input-Output framework for every country, seven world regions and the world (and other aggregations as required).
- **Task 5** Development of additional footprint of final demand datasets and indicators for energy, GHG emissions, and water based on international data and the EORA global and multiregional Input-Output framework for every country, seven world regions and the world (and other aggregations as required).
- **Task 6** Stepwise integration of nationally available material flow datasets into the global dataset pending necessary data quality has been achieved by the respective ONS.
- **Task 7** Reporting for the Global Resources Outlook including data analysis and generation of figures and tables.

- **Task 8** Servicing of the data download and general user interface for the IRP website. Data manipulation to deliver to panel member data requests.

### 2.4. Perspective

By providing the global knowledge base, data and indicators for material flows and resource productivity, the UNEP has positioned itself as the main global player in the increasingly recognised policy domain of sustainable use of natural resources, resource efficiency and waste minimization. The IRP provides data and indicators for a number of SDG targets for which UN Environment is the custodian. This includes SDG 8.4, 12.2 and 12.5 and the relevant indicators.

The reliability of the IRP material flow data will be ensured through a thorough data cleaning and data assurance process. The data quality assurance process is based on the following steps and procedures

- Primary data is sourced from data sources from well-established and trusted data providers such as the FAO, IEA, UNSD, or COMTRADE, among others, creating a source database of many hundred primary materials, secondary materials and products
- The assembly of the research database resolved at a medium level of data aggregations is established through computer code currently in R to allow all data aggregation processes to be followed up through the coding protocols.
- Automated procedures are employed to identify data points in national time series that divert from long term trends to identify data outliers outside of an acceptable range of yearly data fluctuation. The ranges of what is considered an outlier depends on the resource category and the size of the physical economy of a country.
- Such outliers, once identified, are followed through to the source data and are cleaned whenever possible and practical.
- Data fluctuation beyond an expected range that can be explained by additional data kept in the time series such as for example the opening of a large mine or the construction of a hydroelectric dam in a small country.
- More in-depth and detailed data quality assurance processes are difficult to achieve for such an extensive dataset and within the available budgets and need to be undertaken by national statistical offices in the process when they produce their own MFA datasets.
- Certain aspects of the MFA dataset rely on modelling such as for example the information for livestock grazing (based on livestock numbers and feeding demand), crop residues (based on the harvest index), non-metallic minerals for construction (based on data for cement usage) and certain metal ores (where data is reported as concentrate or metal content or in cases of joint production). The models may introduce additional data quality issues and will be discussed for those countries where the impact on data quality is assessed to be considerable. In addition, there are ongoing efforts to build complementary datasets for biological processes or mine information that help improve the global dataset. Ultimately, the most robust datasets will be provided by national data providers however.

Many countries lack the capacity to report this data and the IRP fills a gap during the time when capacity building takes place to empower national statistical offices to prepare their accounts. The IRP also plays an important role in creating the scientific evidence base for establishing comprehensive material flow accounting indicators as relevant SDG indicators that are scientifically robust and feasible to be established. This is important because only comprehensive aggregate indicators allow a full picture of environmental impacts which is required to assess progress towards the SDGs.

The database is already used frequently by international organisations, national government agencies and academics and its use will increase with countries engaging in voluntary reporting for the SDGs and relying on the IRP's data. In addition, the dataset and the indicators presented in

the online database already inform public debate, help raise awareness of issues and allow for problem framing. The indicators from the IRP dataset also inform the process of policy evaluation in regard to the effectiveness of policy implementation in the domains of green economy, sustainable consumption and production, resource efficiency and sustainable natural resource management beyond the SDGs.

While fulfilling an urgent present need, it is expected that the IRP database will continue to add value at a time when most countries are reporting their own national material flow and resource productivity account within the next 5 to 10 years by presenting global and regional assessments and adding a layer of quality control to national datasets in a similar way the IEA or FAO does for their global datasets.

Furthermore, the database and indicators support a process of identifying global targets for a sustainable level of global natural resource extraction and of ambitious and achievable targets with regard to resource efficiency and dematerialization. There is early evidence that information on resource efficiency is also increasingly used by company directors and boards for strategic planning, pointing to further added value in the use of the data by the private sector.

## 3. Policy relevant questions to be addressed

The work stream will extend the current state of scientific knowledge with regard to a set of important questions for material use and resource efficiency that need to be addressed to inform policy making and practice. These questions include:

- 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 global reserves and extraction rates and how might this affect resource availability and affordability in the future?
- 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 are ambitious but achievable targets for countries and regions with regard to resource efficiency and dematerialisation?
- What are priority resources with regard to scarcity and criticality of the resource for the economy?
- What are the most suitable policies and policy instruments to achieve resource efficient production and consumption in OECD and developing countries?
- 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 are sustainable levels of global natural resource extraction and how can they be approached through well designed policies?

The extent to which each question can be addressed depends on ongoing investment into data set updates and extensions which will at the same time increase the policy relevance of the dataset.

## 4. Existing knowledge base and added value of the study

### 4.1. Current state of knowledge and institutionalization of material flows and resource productivity data

Since 2018 the IRP provides the most authoritative global database on materials extraction, trade with materials and material footprints which is available online for general use on the IRP website at http://www.resourcepanel.org/global-material-flows-database.

UN Environment has also embarked on a process to develop and institutionalize a global methodological standard for material flow accounting based on previous guidance available from the European Statistical Office (EUROSTAT), the OECD, and in concordance with the SEEA central framework. Once the global MFA manual has been approved by the international statistical community, a process of capacity building can be organised by UN Environment which over time will enable national statistical offices in Latin America and the Caribbean, Africa and Asia and the Pacific to report material flow and resource productivity indicators. A similar process of capacity building has occurred in the European Union which has enabled all member countries to report MFA data to the European Statistical Office.

While some aspects of material flow accounts are well researched and have become standardized, there is ample opportunity to improve the scientific knowledge and policy practice around MFA. The next step in technical development of the database will include extending the MFA accounts for outflows, which has been pioneered by the World Resources Institute Study The Weight of Nations (Matthews et al. 2000) which while being instrumental for methods harmonization failed to trigger a larger research effort into creating comprehensive material flow accounts that include inputs and outflows and ultimately close the material balance.

Another domain of cutting-edge science for policy delivered through this work stream is the development of the to-date largest supply and use table for the global economy based on the global virtual MRIO laboratory. The new global MRIO developed for the IRP and tailored to the specific needs of capturing global material flow pathways through inter-industry linkages will at its lowest resolution create a table twice as large as the next largest table. It will enable a more thorough and complete attribution of material extraction to final demand by carefully disaggregating biomass and metal pathways through the global economy.

### 4.2. Value proposition to the IRP and the UNEP

The yearly update of the direct and footprint accounts of the global database is an essential activity to keep the service and technical support provided by the IRP up to date. This will allow to grow the user base of the online database which to date already includes important users such as the European Union Raw Materials Scoreboard and the World Resources Institute, among others. The IRP database also provides the physical data for raw material extraction for the Sustainable Consumption and Production Hotspot Analysis Tool (SCP-HAT) of the UN Life Cycle Initiative. It is expected to be used by countries in the context of their voluntary SDG reporting. A good current example is the voluntary SGD reporting of the Australian government who are using the indicators from the IRP database for reporting for target 12.2.

Extending the database for outflows is a major development creating a new path to impact by explicitly linking the policy domains of resource efficiency, waste minimization and greenhouse gas abatement, increasing the voice of the IRP in the natural resources and climate policy debate and establishing the IRP as a trusted advisor for national governments, regional bodies and global initiatives. It will allow to explore the linkages between resources, waste and climate more thoroughly based on a more robust empirical basis.

Improving the methodological base for the material footprint accounts will allow the IRP to continue to play a core role in the international effort of harmonization and institutionalisation of material footprint accounts and indicators, a process which is currently coordinated by the OECD.

The IRP currently has a monopoly position for material flow data which can be extended to include waste flows, a domain that is not well covered or not covered at all by other global actors. The IRP's offering in this domain is a unique product which creates a competitive advantage that is not yet fully explored and utilized. Other resource domains such as energy, water, land use and biodiversity,

emissions and climate are dominated and controlled by other agencies. Whether the IRP should enter into these domains and present a footprint perspective on energy, water, land and emissions is an open question that needs be addressed.

The data set made available by the IRP serves as a satellite account for additional analysis of environmental impacts that are related to material extraction, transformation and use which is another important application that will allow to grow the policy impact of the IRP's work and will be of importance in the debate of global and national targets.

The data set also features prominently in the IRP's scenario and modelling work where the IRP is one of the few players internationally who can provide a comprehensive scenario analysis of resource use and climate for different policy settings. This is an area of policy research which is expected to take off in a similar fashion climate modelling did in the context of the IPCC. As it becomes more understood that climate mitigation will rely on fundamental changes in natural resource use, this contribution of the IRP will become more important over time.

It is fair to say that the path to impact of the material flow and resource productivity database and indicators has focused on the government sector and that the interaction and usefulness of the knowledgebase provided by the IRP for the private sector needs further exploration.

**5. Expertise required**

The IRP currently holds core capacity for undertaking this work through its panel members and a number of partnerships. The consortium to undertake the research 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 Natural Resources and Life Sciences in Vienna, Austria (led by Marina Fischer-Kowalski)
- University of Sydney, Australia (led by Manfred Lenzen)
- University of Nagoya, Japan (led by Hiroki Tanikawa)

and relies on the research capacities of these partners. Additional partners may be sought in future work of this work stream and close collaboration will be sought with other organisations that hold experts in the domain of national material flow accounting in the EU, at the OECD and the United Nations, among others.

IRP panel members will play an important role in data quality assessment and the work stream will seek to involve their expertise more closely as this work progresses.

6. **Timelines and budget**

**Activity 1 – Yearly update and extension of the material flow dataset (direct accounts)**

**Activity 2 - Update of the global MFA dataset (footprint accounts) and extension to additional footprints**

**Activity 3 – Data integration, reporting and online dataset**

**Part B – Activity Based Budget**

| | 2019 | 2020 | 2021 | Total |
|---|---|---|---|---|
| **Activity 1 Update and extension of the global MFA dataset (direct accounts)** | | | | |
| Yearly data updates* | 25,000 | 25,000 | 25,000 | 75,000 |
| Database expansion (output side) | 30,000 | 15,000 | 15,000 | 60,000 |
| **Activity 2 – Update of the global MFA dataset (footprint accounts) and extension to additional footprints** | | | | |
| Yearly data updates* | 15,000 | 15,000 | 15,000 | 45,000 |
| Database extension (other footprints) | 25,000 | 10,000 | 10,000 | 45,000 |
| **Activity 3 – Data integration, reporting and online dataset** | | | | |
| Data integration | 20,000 | 10,000 | 10,000 | 40,000 |
| Reporting (including figures and tables) | 7,500 | 7,500 | 7,500 | 22,500 |
| Online dataset servicing* | 5,000 | 5,000 | 5,000 | 15,000 |
| **Total Cost** | **127,500** | **87,500** | **87,500** | **302,500** |

Essential activities are identified by *

| | | | | |
|---|---|---|---|---|
| Essential budget | 45,000 | 45,000 | 45,000 | 135,000 |
| Additional budget | 82,500 | 45,500 | 45,500 | 167,500 |

7. **Deliverables**

The deliverables of this research program include:

- data sets for material flows and resource productivity as described in the objectives and made available online through the IRP website
- updating of the technical documentation of the datasets and indicators including describing the data quality assurance process and outlining any changes and improvements in the dataset that occur during the yearly updates
- input to the regular reports Global Resources Outlook of the IRP
- a yearly journal publication reporting on the main findings of changes in global resource use in the Journal of Industrial Ecology plus additional peer-reviewed publications that document major methodological improvements
- policy guidance for the interpretation and use of data and indicators in the context of SDG reporting

There is a large potential for data presentation in the form of online maps, analytical tools, country fact sheets and posters which are not included in this budget but may be produced if additional funding was made available.

8. **Target audience and proposed outreach and communication strategy**

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

- The international policy community and the reporting needs for SDG8.4, 12.2 and 12.5
- Environment ministers and authorities in the context of UNEA and through the Global

Resources Outlook
- National policy makers who engage in the policy domains of the 3R's, sustainable consumption and production, resource efficiency, waste minimization and greenhouse gas abatement
- Private sector actors who are interested in robust information about global resource demand and supply
- NGOs pursuing policies in the field of sustainable production and consumption and in relation to the SDGs
- Policy makers who are concerned with managing environmental impacts and relating those impacts to socio-economic drivers and pressures. This group may include ministries of trade and industry as well as other authorities that can support the transition to sustainable consumption and production practices, including through industrial innovation.

The use of the IRP knowledgebase 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. A communication strategy and path to impact analysis needs to be develop in collaboration with the IRP secretariat to maximise the added value the global community gets from the IRPs investment into the database.

## 9. References


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# 3. Scenario Modelling of Integrated Natural Resource Management[6]

**Terms of Reference**

Study Proposal

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June 2020

**Recommendations**

The Working Group recommends that:

(a) IRP panel members endorse the proposed approach and activities to develop IRP scenario modelling and assessment capability;

(b) The IRP Steering Committee approves the proposed work packages and associated budget;

(c) IRP panel members and Steering Committee note the proposed collaborative scenario development activity to underpin and guide the modelling and scenario inputs to GRO2023, which is intended to engage and involve the full IRP community.

## 1. Context and motivation for IRP scenario modelling capability

The International Resource Panel (IRP) produces global assessment reports every four years (starting 2019) that assess current state and trends in natural resource use and decoupling and showcase effective policies for promoting sustainable development in the context of the Sustainable Development Goals (SDGs). Quantitative scenario modelling and assessment are crucial for identifying the implications of current trends and exploring the feasibility and merit of policy options and associated potential pathways, making this tangible to key audiences, and providing the evidence required to motivate action.

A series of workshops and discussions involving IRP experts and policy stakeholders in 2017 identified that existing scenario modelling methods and tools were not capable of meeting the needs of the IRP. No established modelling framework exists that provides both robust representation of resource extraction and throughput for all major categories of resources (accounting for physical

[6] These Terms of Reference were approved at the June 2020 IRP virtual meeting (document IRP.2020.June.05-Scenario Modelling ToRs)

stock-flow relationships), and credible projections and assessment of economic effects of resource use policies.

The IRP thus initiated efforts to develop new integrated scenario modelling capacity in the context of the Resource Efficiency: Potential and Economic Implications report that was commissioned in 2015 by the Group of Seven (G7) countries to:

- *identify the implications of resource use* for the environment, human wellbeing, and sustainable development;
- *contribute to better understanding of decoupling* economic growth from environmental degradation and adverse impacts while enhancing human wellbeing;
- *inform global debate* on emerging challenges and opportunities *and policy action* to promote the sustainable and equitable use and management of natural resources.

The ultimate goal of the IRP scenario capacity is to develop and articulate an implementable paradigm for sustainability, covering sustainable resource use (SDG 12.2), decoupling of economic growth from environmental degradation (SDG 8.4), and the wider issue of living well within planetary boundaries (represented by the wider SDG framework). This will involve both the articulation of a clear conceptual framework, and the progressive development and demonstration of world-leading integrated scenario modelling and a suite of related assessment tools.

The development and implementation of this scenario capability is intended to enhance the contribution and capacity of the IRP to support and guide global debate and policy action, including through:

- providing credible integrated quantitative analysis of the economic and environmental dimensions of resource use, management, and governance;
- assisting coordination of IRP activities and forward-looking analysis to provide a connected and coherent body of work and knowledge;
- contributing to the IRP Global Resources Outlook (GRO) reports and related assessments; and
- encouraging, guiding and contributing to scientific effort beyond the IRP community.

## 2. Progress and achievements of IRP scenario modelling

IRP members undertook the first global macroeconomic scenario analysis of resource use and the impacts of ambitious resource efficiency policies as part of the first package of work commissioned by the G7, as set out in the IRP report of March 2017 and two journal articles. Achievements included:

- the first demonstration of how to adapt an established CGE economic modelling framework to include physical resource extraction and trade (DE, DMC, and PTB), for

ten categories of resources – an approach since adopted in the OECD ENV-LINK model;

- the first forward looking footprint analysis (attributing resource use to final consumers) based on further analysis of the modelling results.

In 2017 the IRP commissioned more ambitious analysis using a multi-model approach to provide scenario projections for use in the first Global Resource Outlook, released at UNEA in March 2019. This work linked a global multi-region economic model with a global land use model to:

- assess and compare scenarios for *Existing Trends*, *Resource Efficiency*, and *Towards Sustainability*, going beyond the previous G7 resource efficiency analysis to address sustainable consumption and production;
- model the *Towards Sustainability* scenario integrated policies and actions to promote resource efficiency, energy efficiency, improved nutrition and reduced food waste, and to address climate change and biodiversity conservation – integrating key aspects of seven SDGs (SDG 2, 6, 7, 8, 11, 13 and 15).
- show indicators including resource use (Domestic Material Consumption DMC), greenhouse emissions, land use (agriculture, forest, other natural land), and per capita energy use, calorie supply, and income (GDP per capita) – all from 2015 to 2060 for the world and high, medium and low-income groupings.

We are not aware of any other published analysis that covers this broad scope along with robust representation of economic impacts and implications.

The completion of the scenario modelling work (TOR approved in 2018) was paused due to funding constraints. Supplementary analysis to situate the global material demand scenarios in the context of the Shared Socio-Economic Pathways (SSPs) was undertaken and has since been published in the Journal Resources, Conservation and Recycling. Additional analysis would be required particularly to tease out the contributions of different scenario elements before the GRO2019 scenario analysis can be submitted to a top tier journal.

### 3. Coordination of forward-looking IRP work

The Scenario Modeling Working Group (detailed in Section 8) discussed the relationship and potential contribution of integrated scenario modelling to current and proposed IRP Workstreams. Key points of agreement included:

- all forward-looking IRP analysis should use consistent set of assumptions, and be designed and implemented to provide synergies across Workstreams where relevant and practical;
- integrated scenario modelling is not always required or practical, and in many cases scenario modelling would not provide good value for money in informing policy and business decisions and actions.

The meeting also discussed the importance of good forward planning in ensuring delivery of quality and analysis and results, and identified a number of practical ways

to streamline contracting of modelling work (to be progressed by Working Group members and the secretariat – see Section 6).

## 4. Proposed priorities for IRP scenario modelling

The Working Group agreed, given likely budget resources, that efforts of the scenario modelling Working Group in the next few years should focus on:

- delivering for the GRO2023 and informing IRP work on science-based targets;
- supporting coordination and mutual consistency of other forward-looking IRP analysis (as discussed in Section 3 above), without undertaking additional modelling unless this is explicitly agreed and included in the TOR of new Workstreams;
- improving and demonstrating the multi-model approach through expanding the number and types of models included in the framework, with IRP-funded effort focusing on implementing linkages (including essential incremental adaption of models to allow proper linking), rather than substantive development of new or existing models;
- strategic engagement with the wider integrated assessment community to promote modelling and analysis of resource use, resource efficiency and circular economy, and decoupling.

The meeting agreed that IRP modeling activity should be open and inclusive, and that all elements of the multi-model framework should be able to be replaced by another model that performs the same essential functions in order to improve overall functionality of the multi-model framework.

## 5. Proposed approach, scope, and implementation of scenario modelling

### 5.1. Development of agreed resource use scenarios

The Working Group agreed that the scenarios and issues to be explored through forward looking modelling and analysis should be co-developed by the GRO and scenario modelling Working Groups, in consultation with the wider panel and Steering Committee.

The Working Group also agreed that it would seek to engage the wider integrated assessment community in the development of shared ‘benchmark’ or ‘reference’ scenarios for resource use, that complement and extend the existing set of Shared Socioeconomic Pathways (SSP) scenarios so they are relevant to issues of resource use, management and impacts, and related issues such as resource efficiency and circular economy. This engagement is considered important but less important for the IRP than efforts to agree scenarios and issues for analysis in GRO2023.

### 5.2. Rationale and key elements of the proposed IRP modelling approach

The Working Group affirmed that IRP requirements are best met through a flexible multi-model strategy, and agreed several general principles to guide the development and use of IRP modelling efforts:

- the approach should support analysis of resource extraction, use, management, impacts and decoupling possibilities along the full DPSIR chain;

- the approach and all model elements should have a high degree of transparency (supported by model documentation) including the use of open source code where appropriate;
- the approach should allow interoperability, including substitution and use of alternative model elements within the framework;
- IRP modelling activities should be undertaken by a consortium of credible experts and organizations, each contributing in their area of strength;
- IRP modelling activities should promote an inclusive approach that enables participation by, and engagement with, a wide variety of experts and stakeholders – and should not establish a single model or organization as a monopoly provider to the IRP;
- IRP modelling activities should promote and support open inquiry and interaction with the wider integrated assessment community, including sharing data and methods as much as practical, and building towards publication of scenario results through a results database.

The Working Group discussed the lessons from recent IRP scenario modelling activity and priorities for improving the existing framework. The group agreed the multi-model approach should be expanded to provide links to all major provisioning systems, accounting for most of the resource and energy use. The group agreed the following modelling domains should be included:

- urban futures and outlooks, including stock of residential and other buildings, urban form and density, and urban transport infrastructure;
- global transport and mobility systems, including aviation and shipping and relevant fuels;
- stationary energy, including electricity, gas, hydrogen, bioenergy, and synthetic fuels, and industrial heat and other heating and cooling;
- key classes of energy using assets, such as energy intensive industry and durable household appliances;
- water use and extraction-related water stress (at least for agricultural water use); and
- capacity to track flows of important metals and minerals through extraction, transformation, use and disposal.

The Working Group has identified at least one existing candidate model for each of these domains, most of which are owned or managed by organizations with links to the IRP (see section 8 required expertise).

This set of domains would complement the IRP capacity demonstrated in the GRO2019 analysis. Due to time and budget constraints, the modelling will focus on linking and integrating two model types (complemented by assumptions and inputs drawn from other published work and reference scenarios), involving:

- a global multi-region multi-sector economic model (GTEM.ME3), with embedded technology bundles for electricity generation, heavy industry (iron and steel and cement) and other energy use, providing projections of physical resource flows for ten major resource categories (four biomass, three fossil fuel, two metal ores, and non-

metallic minerals) in addition to economic activity by sector, trade, energy, greenhouse emissions, and many other variables;

- a global multi-region land use model (GLOBIOM), providing projections of land use categories (pasture, cropping, plantation forest, other forest, and other natural land), supply of food, fiber, forest products, and bioenergy, and other variables.

Implementation of this approach would provide a robust analytical framework for forward looking
assessments of the volume, patterns and impacts of resource use, and associated 'wellbeing services' and environmental impacts. The approach will also enable analysis of resource flows and stocks in different levels of detail across relevant elements. This will include, for example, tracking extraction, use and disposal of specific metals (such as copper) in energy generation, transmission, and energy using appliances and equipment, which enables identifying additional options for resource efficiency and circularity.

### 5.3. **Implementation of multi-model approach and GRO2023 scenarios**

Given the focus on linking existing models, the Working Group considers there is potential to implement all or most of the proposed model elements, delivering substantial improvement in the resolution of scenario projections.

The group thus proposes the following activities to develop and implement the GRO2023 scenarios:

- identify the modelling requirements for GRO2023 scenario modelling and analysis, together with the GRO2023 Working Group, wider Panel and Steering Committee in Q3 2020;
- undertake rapid model linking activity, to be concluded by late 2020, to test and extend the multi-model approach and underpin smooth implementation of the scenario analysis;
- recommend detailed scenarios, modelling strategy and scenario selection to provide input to the GRO2023 no later than the Fall 2020 Joint Meeting;
- implement the GRO2023 scenarios and related analysis in 2021 and early 2022 (delivering to peer review by mid-2022), in collaboration with the GRO2023 Working Group, and drawing on and integrating wider IRP insights and inputs as agreed;
- seek to align the GRO2023 modelling with a tailored joint technical deliverable, providing additional detail for the UN ESCAP region, with ESCAP providing or arranging an appropriate funding contribution (see section 12).

The schedule for the modeling work will be organized in close collaboration with the production of the GRO 2023 to ensure full compatibility between the two processes.

## 6. Added value

The proposed IRP modelling and scenario capability adds value to existing capacity by establishing a novel, flexible multi-model framework. It consists of a multi-sector multi-region economy-wide model as a core component. The economic model is coupled with models for energy technology choice for stationary energy and transport fuels, land-use

and agriculture models, and importantly a built asset model. In combination these models cover the main socioeconomic activities that in sum are responsible for 80 per cent of overall environmental pressure and impacts which include housing, transport, food, and energy.

The proposed IRP capability will build on existing modelling capability in integrated climate and earth-system assessment, energy modelling, models for land use and food supply, and advanced assessment methods such as life cycle assessment and environmental impact assessment, environmentally extended input-output assessment, and environmental satellite accounts.

Each of these existing modelling communities cover important aspects of resource use, however collectively they still leave important gaps that need to be closed in order to meet IRP needs.
Integrated climate and earth-system assessment models tend to focus on climate-energy-economy or climate-land-food relationships. They generally do not cover material flows, lack a stock perspective for most economic sectors, and usually do not account for non-climate pressures and impacts other than – in some cases – air quality and biodiversity-related land use. These gaps will be addressed progressively by the proposed new IRP scenario modelling capacity.

Energy models typically do not account for energy distribution and transport infrastructure. Land- use models usually focus on terrestrial resources and overlook marine resources. Most Life Cycle Assessment (LCA) databases focus on US, EU and Japanese data and lack information for developing countries. Assessments based on observational data and forward-looking assessment is possible but not well established. LCA assessment are usually product- and process-focused which is also the case for environmentally extended I-O analysis.

The focus of the new IRP capability is to establish an analytical capacity that allows for in-depth assessment of industrial metabolism, the use of materials and energy across the whole life cycle and the disposal of waste and emissions. This provides a more comprehensive picture of overall environmental pressures and complements the current concern of climate change and biodiversity loss, enabling policy scenarios for natural resource use across the board, for the potential of resource conservation and its co-benefits for climate and biodiversity.

Additional models for water supply, biodiversity, air quality, broader environmental impacts and nutrient flows are desirable but are not proposed to be included in the initial multi-model framework.

The proposed modelling framework is open, allowing additional models to be added to provide greater detail and depth where desired. The scenario modelling group is also committed to promoting a diversity of tools, models and perspectives – each with their own strengths and distinctive contributions – rather than adopting a single provider (and "view of truth") approach.

## 7. Policy relevance

To be successful, environmental and sustainability policy cannot operate in isolation, but instead requires an iterative and integrated approach – as demonstrated and reinforced by the SDGs and by many multinational and national policy programs and initiatives (such as the G7 resource efficiency initiative). This requires a strong sustainability policy framework and a new level of integration and whole of government engagement and considers economic, employment, distribution, and environment and health outcomes. Existing tools for policy analysis are not well suited to supporting evidence-based decisions and consensus building across this very comprehensive set of objectives.

The IRP's scenario modelling capability addresses this need for comprehensive policy analysis across traditional domains of public policy by developing a multi-model framework which can address both standard economic issues and broader environmental, social and health issues. It is therefore better suited to test policy alternatives in unchartered territory than existing analytical models and approaches. The proposed framework will enable the IRP to establish a coherent policy narrative on the merits of decoupling economic growth from environmental degradation. Perhaps more importantly, it will allow analysis of the contribution of different economic sectors, the identification of specific programs for important provisioning systems, and the development and assessment of policy tools which can inform and support a comprehensive sustainability action agenda which can be rolled out by governments and businesses at city, national and regional levels.

Robust and reliable scientific information about the intersection of public policy, changes in socio- technical and provisioning systems, and economic actors are important to guide a transition from current economic regimes and ways of producing, distributing and consuming into new ways which rely much less on a constant and high flow of natural resource inputs and waste and pollution disposal and make use of circular economic strategies in the domains of material and energy use.

Such strategies for transforming existing socio-technical and provisioning systems that deliver housing and shelter, mobility, food, energy and water to businesses and households require legitimacy, need be economically attractive, need to allow for fair distributional outcomes and will ultimately rely on transition management. The capacity to guide socioeconomic systems toward sustainable pathways relies on scientific evidence and modelling to be able to explore the corridor for sustainability policy and anticipate potential gains, to identify potential winners and losers, to guide transitional support, and to avoid unintended consequences. To provide such crucial information on a regular basis is the aim of this new IRP scenario and modelling capability.

## 8. Required expertise

The assessment will rely on a working group composed of IRP members and research institutes that are leading in the specific modelling areas specified for the integrated modelling suite. The working group will be co-chaired by Steve Hatfield-Dodds and Michael Obersteiner. The administrative lead of the work will rest with CSIRO, and Heinz

Schandl will be the project manager. The following members of the Working Group will lead on specific components:

Project leadership (all work packages): Steve Hatfield-Dodds and Michael Obersteiner

- CSIRO-GTEM – economy, energy, transport, agriculture, materials (Heinz Schandl)
- IIASA GLOBIOM – climate, land use, water, biodiversity, food (Michael Obersteiner)
- PBL TIMER/IMAGE - integrated assessment (Detlef van Vuuren)
- Leiden University – stocks and flows of metals (Ester Van der Voet)
- UCL – transport and energy modelling (Paul Ekins)
- NTNU/University Freiburg – REEC – resources, energy and climate (Edgar Hertwich/Stefan Pauliuk)

This leadership group will work across all work packages and components of the project to ensure consistency and coherence of the set of deliverables.

## 9. Work packages and deliverables

### 9.1. Overview

This modelling work is organized into two main phases which include **a model sprint (WP1)** which tests the functionality and linkages among the collaborating models by running the models and
**a core modelling phase (WP3)** in which all scenarios are fully specified and run and results are analyzed and tested for their robustness and reliability and prepared for including in the next iteration of the Global Resources Outlook.

In parallel, the modelling project team and GRO2023 team will engage with the broader IRP community in **a scenario building exercise (WP2)** where core aspects of the storyline will be developed, and core assumptions are tested for their policy efficacy.

The timelines of the project will be aligned with the timelines of the Global Resources Outlook which to date are not available. It can be expected that the model sprint will be achievable in around 8 months (from when contracts are signed) while the full model runs, and analysis of results will require 14 to 18 months.

WP1: Model sprint

WP2: Scenario planning

WP3: Full model runs for a series of scenarios, suitable for publication in the 2023 global assessment

The three proposed work packages each represent an essential component of the proposed next phase of work. The model sprint in WP1 involves essential and urgent work required to enable delivery of more detailed substantive modelling in WP3, informed by the scenarios developed and agreed through WP2.

We outline proposed key deliverables in Table 1 and describe each work package in more detail below.

### 9.1.1. WP 1: Model sprint

1. Work Package 1 will develop and articulate a clear conceptual framework, linking material flows, access and benefits of natural resource use, planetary boundaries (ecological limits), and policy challenges associated with different types of resources. In more detail work package 1 will revisit the IRP's overall analytical approach (e.g. DPSIR) and elaborate on the correspondence with the IRP model cluster in view of carrying out integrated impact assessment for the new GRO.

2. Develop a conceptual architecture for the multi-model approach identifying relative strengths and complementarities of models, capability gaps in the overall model cluster, and potential issues that may arise from model characteristics with respect to potential policy messages (e.g. major policy conclusions on innovation requires innovation to be represented in models).

3. Develop a simplified metamodel of the model cluster which will be calibrated to scenario outputs from IRP models.
    - Develop the meta-model
    - Calibrate to existing scenarios of the IRP models (and perhaps wider)
    - Determine uncertainty ranges of a range of parameters
    - Run a very large variety of scenarios in combination with uncertain model parameters
    - Identify essential model variables and key scenario assumptions that drive system behavior
    - Run a small set of well-elaborated headline scenarios to guide the model linking approach
    - Provide input to scenario storyline refinement for large scale modeling
    - Provide provisional early quantitative results (orders of magnitude should be correct) for input to GRO narrative building

4. Agree on essential and additional input/output variables for each model engaged in the multi-model approach and determine linkage points between models

5. Prepare a model run of all models involved in the IRP model cluster to create model outputs for comparing model behaviour, test completeness of results to cover all aspects of economy, resources and environment relationships

6. Review results and identify anomalies and outliers to decide about the final model architecture and linkage points for the core model runs

7. Decide about the form model linking will take for next stages of core model activity, such as:
    - Soft coupling, hard coupling, look-up tables
    - Sharable modules

- Detailed model protocol incl. a GANT chart of preparation of I/O variables, model runs, model inter-comparison, and final model output tables

- Clear conceptual framework and architecture of multi-model
- Identify relative strength and complementarities of models
- Understand capability gaps
- Agree on essential input and output variables and model linkages
- Prepare a model run involving all models
- Review results and identify anomalies and outliers

*Figure 1 Workflow work package 1 'model sprint'*

**Deliverables**

1. Technical Report about experiences and learnings from the model sprint including an assessment of key strength and weaknesses of the proposed multi-model framework
2. Short technical report about the core insights from the meta-modelling
3. Technical annex about model architecture and model linkages

### 9.1.2. WP2: Collaborative scenario development

Different types of scenarios can be used to deliver to specific stakeholder needs, and they can be characterized as predictive, exploratory, aspirational and normative. These four types of scenarios correspond to four types of questions that the IRP will be interested in regarding future material use, emissions and waste and the related environmental impacts of climate change, pollution, waste accumulation in landfills, resource depletion and biodiversity loss.

| | | | |
|---|---|---|---|
| | **What will, or is likely to happen if we do not change?** – based on the assumption that existing trends and current thinking and practices to continue unchanged into the future, i.e. predictive reference scenarios | | **What could happen?** – taken into consideration combinations of uncertain and largely uncontrollable drivers of change,i.e. exploratory scenarios |
| | **What should happen?** – based on the desired future and creating a vision that helps define goals to guide interventions, i.e. aspirational scenarios | | **What can happen?** – based on the potential outcomes of proactive interventions aimed at systems change, i.e. normative scenarios |

*Figure 2 Main purpose of scenarios to describe future states of complex systems*

As a general principle, scenarios will be co-developed by the broader IRP community and be based on input and review through the panel and steering group and will be co-owned by the IRP community which is a major step forward from previous IRP modelling work.

- Work package 2 will engage members of the steering group and panel members in a scenario development process that sets out with developing storylines about plausible futures taken into consideration core trends, drivers and variables.
- Core intervention points into the complex interactions between economy and the environment facilitated by social, political and economic decisions are identified and policies that enable a step change in advancing sustainable consumption and production are identified. identifying policy questions and selecting policy options will be a main task of the co-design process.
- Scenario storylines and policy options are quantified into numeric scenario settings to the extent possible and the resulting assumptions are tested and evaluated by the panel and steering group to test the plausibility and accuracy of the translation of qualitative into quantitative information
- Storylines, policy alternatives and commensurate numeric assumptions will guide the model runs and respond to the questions the broader IRP community wishes to see addressed through the scenario modelling activity

**Deliverables**

- Report of the scenario planning process outlining possible futures and main policy options for achieving a step change in a sustainability transition 'Visioning the Future We Want' resulting in a set of shared and co-owned IRP scenarios
- Core numeric variables representing the alternatives scenario storylines and policy options to guide the setting s for model runs

#### 9.1.3. WP3: Core model runs for a series of GRO2023 scenarios representing different levels of policy ambition and different potential socio-economic contexts

Work Package 3 will define a series of scenarios as input to the Global Resources Outlook 2023 based on the storylines and policy questions and policy options co-developed with the IRP panel and steering group (see work package 2). These scenarios will investigate future resource use with respect to biomass, metals, non-metallic minerals, fossil fuels and water. The work will be based on the WP1 outcomes with respect to the linkages between the models (and the potential use

of multiple models). In principle, macro-economic scenarios developed by the CSIRO model suite will be used as input into the more physical oriented resource models describing resource demand.

The exact way the models will be used depends on the focus of the GRO-2023 report. The proposal will therefore be elaborated in detail based on further development of the GRO-2023 outline. In order to link the GRO-2023 report to both the previous GRO report and the work in other assessments, the scenarios will be coupled to the so-called Shared Socio-economic Pathways (SSPs). We envisage key scenarios for this exercise will focus on:

| | | |
|---|---|---|
| | Reference or existing trends scenario (based on SSP2) | describes future demand for resources and related environmental issues for current policies and socio-economic development trends |
| | Resource Efficiency scenario | derived from the reference scenario focus on the possible impacts of efficiency measures |
| | Circular Economy scenario | builds on the resource efficiency scenario – adds additional measures related to recycling, lifetime extension and possibly lifestyle change |
| | A greenhouse gas abatement scenario | |
| | A sustainable landscape (land and water use) and food security scenario | |

*Figure 3 Core scenarios to be developed for work package 3*

These scenarios can be combined in various ways to demonstrate the contribution of resource efficiency, climate and land use policies to overall environmental outcomes. Additional scenario runs will allow to test the sensitivity of specific assumptions and to deliver a set of robust and reliable forecasts.

In order to elaborate and assess these scenarios, the full model suite is needed. For instance, looking at the circular economy scenario requires a detailed model of the stocks and flows of different materials in the economy. Therefore, the proposed model-suite allows for a coupled analysis of both the interactions between resource use and macro-economic development (top-down) as well as the detailed analysis of stock/flows of food, bioenergy, timber, land, fossil fuels and other energy carriers, metals and non-metallic minerals.

**Deliverables**

- A set of scenarios for tailored for the reporting needs in the Global Resources

Outlook (GRO) including economic variables and resource use variables modelled after the initial GRO report results

- A master data set summarizing all key results from the model runs for all scenarios to be used in the GRO
- A technical annex describing the methodological decisions that underpin the different scenarios including core scenario setting and uncertainty assumptions

The exact timing of deliverables will be outlined in a separate budget and implementation plan and will be adjusted to the needs of the Global Resources Outlook production process.

## 10. Target audience and proposed outreach and communication strategy

The target audience of the scenario and modelling work are national policymakers, regional bodies and the global policy community. The initial scenario modeling work for the Global Resources Outlook 2023 has demonstrated the communicative power of modelling results that can present an economically attractive case for resource efficiency and environmental and resource conservation. Only if we can present policy options that are simultaneously attractive for economic and environmental outcomes can we gain attention from the main decision makers in the policy community, i.e. finance and treasury departments, and get sustainability objectives mainstreamed into national policy agendas and development plans. This does not mean that harmonious economic and environmental outcomes will be easy to achieve and will not require substantial change from the status quo but will nevertheless add legitimacy and acceptability to the sustainability cause and may drive investment in well-designed policies and incentives that change current resource and emission intensive pathways of securing human well-being.

The new multi-model capability, once established, will enable the IRP to address more specific policy questions in a whole-of-system approach and may result in a series of policy briefs for sectoral approaches in agriculture, mining, energy, manufacturing and urban development, and will include final demand management strategies and equity issues. This will allow the IRP to provide scientific evidence to relevant policy debates and to present information that is coherent with the behavior of the global economic system and its linkages to ecosystems and natural resources.

Once fully developed, the IRP scenario and modelling capability will enable the IRP to become a main player in analyzing the synergies and trade-offs that exist within the SDG agenda and to provide regular information about the achievements of the implementation of the 2030 agenda.

Most importantly, commanding such coherent modelling capability will enable the IRP to engage with new and different stakeholders outside of the narrow environmental policy domain and will make the IRP a relevant source of advice for economic and social policy questions. This will also most likely have positive impacts on the IRPs global visibility and its funding and support structures.

11. **Budget, resources and time frame**

This proposal focuses on work required for the IRP to enable the next iteration of IRP scenario modeling to inform the Global Resources Outlook 2023. The modelling work will be based on a multi-model framework tailored for the purposes of the IRP and delivered by a collaboration of research partners that are renowned for their modelling capability.

We strongly favor an inclusive approach to the work, engaging a good cross section of IRP Panel members and their host institutions – and facilitating collaboration beyond the Panel. It is important to engage contributors who bring a variety of disciplines and perspectives, and who work across a variety of contexts and stakeholders.

Implementing the next phase of the IRP modelling work and establishing the multi-model framework will take time, effort, expertise, and resources – and thus will require clarity and confidence to achieve the best results. The split of the work into a model sprint and a core modelling phase allows to establish the full modeling framework and model linkages early in the process, creates ample opportunity to revise the model structure when required, and helps reduce the risk of failure. The core modelling phase will be guided by the experiences gathered during the model sprint.

We estimate the proposed work will require a budget of USD 550,000, as outlined in the presentation to the IRP Steering Committee at the meeting in Slovenia in November 2019, plus funds for printing and project management. This would cover all the essential and desirable deliverables for WP1, WP2 and WP3. The proposed budget assumes an inclusive approach to the collaboration and that research providers co-invest in the implementation of the work.

The time available for this work is now very tight. In order to commit the resources required to deliver this work, and the associated co-investments, the modelling teams require approval of the full package of work, including both WP1 and WP3, before commencement.

12. **Indicative budget requirements**

The budget requirements for the second phase of IRP scenario modeling for the GRO 2023 are shown in Table 1. This assumes five modelling teams will be involved the work, drawn from CSIRO, IIASA, UCL, NTNU/UFB and CML/PBL (with funding divided equally between the contributing teams).

*Table 1. Indicative budget requirements for proposed GRO2023 scenario modelling*

| | Modelling teams (a) | Model Linking | Deep dives/ Contingency | Total |
|---|---|---|---|---|
| Developing Scenarios | (b) | - | - | 45,000 |
| Rapid model linking and demonstration | 75,000 | 30,000 | 15,000 | 120,000 |
| Project management | | | | 15,000 |
| Sub-total 2020 | | | | 180,000 |
| Core model runs | 200,000 | 30,000 | 40,000 | 270,000 |
| Results interpretation and technical write-up | 75,000 | - | - | 75,000 |
| Project management | | | | 25,000 |
| Sub-total 2021-2022 | | | | 370,000 |
| Publishing/Printing (Sec) | | | | 10,000 |
| **Total** | | | | **560,000** |

Notes: (a) Modelling team funding covers five teams, as noted in text. (b) Funding would support participation by the scenario and GRO2023 working groups, modelling team members, and other member of the IRP. Participation by other stakeholders, such as Steering Committee members, is normally self-funded.

## 13. Potential cooperation with UN ESCAP on modelling activities

The Bangkok meeting of September 2019 included information exchange and discussion between the Working Group and several UN ESCAP divisions (including economic policy, environment and development, energy, transport and trade) involved in modelling and the development of knowledge products for member countries.

- The Working Group agreed there was substantial overlaps between IRP scenario efforts and capabilities, offering potential synergies around work towards the GRO2023.
- Opportunities and proposed next steps need to be discussed with ESCAP and may result in an MoU about collaborating in the scenario modelling domain in the future.
- Similar opportunities exist for the economic commissions of Africa and Latin America and could be discussed with the relevant representatives. The engagement with UNESCAP would showcase how we can engage with other regions such as Africa and the Americas through the economic commissions.

## 14. Collaboration with the OECD and other policy actors

The IRP modeling working group will seek to continue collaboration with the OECD to ensure cross- fertilization, collaborative learning and complementarity of the

activities of the IROP and the OECD. This will be ensured through regular meetings with the OECD modeling team and sharing of methods and data.

In a similar vein we will attempt to create linkages with other important players on the modeling and forecasting community and will compare modeling outcomes with IEA, IPCC and other players.

## 4. Global Resources Outlook 2023

**Terms of Reference**[1]

### 1. Purpose & Objectives

*Rationale*

The launch of a Global Resources Outlook (GRO) at United Nations Environment Assembly 4 (UNEA-4) in 2019, as well as its predecessor in 2017, were major breakthroughs for the IRP. The Panel is now recognized as an important player in the global assessment space, and an increasing level of anticipation of upcoming reports is to be expected. Moreover, a specific request was made by the UNEA-4 to the IRP to continue reporting on sustainable resource management. UNEA-4 resolution UNEP/EA.4/L.2 on Sustainable Consumption and Production states:

*"The United Nations Environment Assembly, ...*

*Welcoming the analysis by the International Resource Panel in its report Global Resources Outlook 2019: Natural Resources for the Future We Want,*

*Noting current trends of exploitation of natural resources and its impact on the environment as laid out by the Global Resources Outlook 2019, highlighting that resource extraction and processing of materials, fuels, and food accounts for more than 90 per cent of global biodiversity and water stress impacts and approximately half of the global climate change emissions (disregarding climate impacts related to land use),...*

*1. Invites Member States to consider approaches and polices to achieve sustainable consumption and production including but not limited to improving resource efficiency and moving towards circular economy when developing relevant national plans and policies, sustainable development strategies and sector policies or equivalent to decouple economic growth from environmental degradation and primary resource consumption and to take into account, when doing so, the outcomes of the 6th Global Environment Outlook and the Global Resources Outlook 2019: Natural Resources for the Future We Want;...*

*13. **Invites the International Resources Panel to continue to regularly report to United Nations Environment Assembly, including through its Global Resources Outlook reports,** about current trends and emerging issues related to the use and management of natural resources, over-consumption and their impact on the environment, the economy and the society and people, including scenarios, good practice examples and policy options…"*

*Key Objective*

GRO 2023 is the response of IRP to the request from UNEA-4 and as such it needs to address (quoting from the resolution requesting GRO 2023):

- *current trends and emerging issues related to the use and management of natural resources,*
- *over-consumption and their impact on the environment, the economy and the society and people*
- *including scenarios,*
- *good practice examples*
- *policy options*

in an integrated manner that provides not only an analysis of drivers, pressures, state and impact, but also looking at policy responses. In other words it needs to be an integrated assessment dissecting the developments in our material consumption, linking developments

[1] Approval confirmed via email on 4 October 2021.

in systems such as food, fuels and infrastructure, pointing at concrete solutions to challenges posed by the rapidly growing use of resources.

This entails four blocks of information and analysis:

- Provide the international community with an updated overview of the present state of natural resource use and an outline of current and future trends. The natural resource use will be analysed in terms of different types of natural resources, geographic areas and economic sectors.
- Provide objective and accurate information about the environmental, economic and social implications of the present resource use trends. This should allow to qualitatively assess the wider implications of today's resource use and its compatibility with the sustainable development goals formulated by the international community.
- Formulate targets (orientation values) quantifying the sustainable use of natural resources over the next years, and developing a monitoring grid.
- Advice on policies and measures in order to achieve these targets (orientation values). This part of the report will be closely coordinated with the ongoing IRP research on science-based targets and scenario modelling developed for the GRO 2023.

In doing so the report will speak to leaders at all levels: Whether global or local leaders, business, financial systems, youth, parliamentarians. The report target as our 'captive audience' those who want to be at the forefront of the transition and cultivate alliances in advance. The report will also deliver actionable knowledge based on examples: research that engages, exemplifies, encourages & enables action.

**2. Relation with the IRP objective and strategy of the corresponding cycle**

The existing IRP strategy (2018-2021) refers to the Global Resources Outlook under High Impact Priority Area 1, and it is expected that the strategy for the period 2022-2025 will have a similar task, given that it is a formal UNEA-4 request. The Terms of Reference is therefore presented as part of the 2022-2025 Work Programme of the International Resource Panel, under High Impact Priority Area (HIPA) 1 - Current Trends and Future Prospects for Global Resource Use and Sustainable Resource Management.

From a formal view point the goal of the GRO 2023 is to respond to the request from UNEA to the IRP. However, the report also has a higher strategic importance to the IRP. The report should present a complete and global picture of natural resource use; how natural resources contribute to society's development, and how they can impact negatively if they are used in an excessive and inadequate way. The IRP intends to update regularly the report, and make it the reference document for both policy makers and public administrators responsible for formulating natural resource use policy, as well as for orienting the scientific community towards emerging and relevant issues.

**3. Urgency, Complexity, Existing Knowledge Base and Scope**

Demographic developments and the increasing purchasing power of a broader part of our societies are generating a growing demand for goods and services around the world. The increasing relocation of production from technologically advanced countries to less technologically enabled countries has led to decreasing trends in global natural resource efficiency and productivity. In so far as these products and services are produced with unchanged technologies, organizational types and business models, this will lead to an increase in natural resource use and impact. While the global Covid pandemic has led many countries to reconsider the benefit of globalisation, there is little expectation that the response

to the crisis will be a major shift in development except for isolated niches linked directly to pandemic response (protective equipment, vaccines, etc.).

The current trends in natural resource use in turn affects both ecosystems and socio-technical systems. These effects may be due to the depletion of limited reserves but - more frequently - to the impacts related to their extraction, transformation and final consumption. They can influence both human health and ecosystem equilibrium and related ecological services. This was demonstrated clearly in the first Global Resource Outlook delivered in 2019 at UNEA 4. Here the headline figure of 50 % of greenhouse gas emission and 90 % of biodiversity loss as well as one third of health impacts (measured on the basis of particulate matter) being attributed to resource extraction and processing, was a message that clearly illustrated the urgency of addressing material consumption as a means to address global challenges.

As clearly stated in the 2019 Global Resources Outlook, the use of natural resources and the related benefits and environmental impacts are unevenly distributed across countries and regions:

- The per capita material footprint from high-income countries is 60% higher than that of the upper-middle-income group and thirteen times the level of low-income groups.
- The per capita environmental impacts of high-income countries is three to six times those of the low-income groups.
- The upper-middle income countrie had a particularly high-impact from 1970 to 2017. Domestic Materical Consumption in 1970 was 6 tonnes per capita, while in 2017 it went up to 20 tonnes per capita or 56% of the global share of domestic material consumption in 2017. This group also has a higher per capita material consumption than the high-income group as of 2012.
- Practically no change has occurred for low income countries despite needing it the most

A more strategic and efficient use of natural resources also has an important impact on economic growth and jobs, as demonstrated by the IRP report "Efficiency Resources: Potential and Economic Implications".[1].

The Intergovernmental Negotiations on the 2030 Agenda for Sustainable Development have delivered an ambitious set of Goals, Targets and Indicators that sketch a shared vision of the future on our planet.

The topic of adequate use of the natural base for a region's own development, therefore including natural resources, entered in several objectives and targets. For example:

- halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains (target 12.3)
- substantially reduce waste generation through prevention, reduction, recycling and reuse (target 12.5)
- effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices (target 14.4)
- ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services (15.1)

However, the topic of natural resources, their use and management, is globally and comprehensively discussed in objectives 8.4 and 12.2. For all signatory countries, objective

[1] Paul Ekins and Nick Hughes, Stefan Bringezu, Charles Arden Clarke, Marina Fischer-Kowalski, Thomas Graedel, Maarten Hajer, Seiji Hashimoto, Steve Ha ield-Dodds, Petr Havlik, Edgar Hertwich, John Ingram, Katja Kruit, Ben Milligan, Yuichi Moriguchi, Nabil Nasr, David Newth, Michael Obersteiner, Anu Ramaswami, Heinz Schandl, Sangwon Suh, Mark Swilling, Ester van der Voet, Brian Walsh, Jim West and Henk Westhoek (2017). Resource Efficiency: Potential and Economic Implications. A Report of the IRP, International Resources Panel.

8.4 requires to 'Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, …with developed countries taking the lead'. Meanwhile, the goal 12.2 aspires 'to achieve the sustainable management and efficient use of natural resources'.

The first of the two objectives emphasizes in particular the transformation dynamic and on the progression per unit of time. The second one focuses on achieving the ultimate goal, the sustainable use of resources. The proposed indicators[1] are identical in both cases and do not provide any additional information. In particular, the definition of "sustainable use of resources" requires reflection and analysis.

Both objectives require a radical transformation of consumption patterns, technologies and organization of society, which will result in increased natural resources use efficiency. Therefore, pursuing better use of natural resources means accompanying this improvement towards the sustainable development goals. The IRP's GRO report analyses, proposes and monitors this transformation from the perspective of natural resources.

## 4. Structure of the report

As an integrated assessment, GRO 2023 will be built on the knowledge base of IRP, not merely as a summary of existing work. It will synthetisize insights from different work streams, and will have a particular focus on capturing the totality of the production and consumption systems supported by the modelling work that will allow us to explore the consequence of different policy pathways on the impacts and scale of resource consumption.

GRO 2023 will need to make a unique contribution to the plethora of reports coming out within the next 3 years. There is a need to develop a positive narrative around opportunities, co-benefits and benefits of acting fast in the resource space with the underlying message that addressing global challenges requires action on resource use. Transition to a decoupled, resource efficient society and economy could be a potential storyline of the GRO 2023 and its modelling. This includes perspectives on the most important solutions and levers to reduce resource consumption and/or impacts. It should also include a perspective of resource sufficiency as a way of addressing the regional disparities highlighted in the GRO 2019.

The report should not only include best practices and good examples, but also provide a fundamental look at obstacles and lock-ins dominating the current system. In general, the goal is a truly integrated assessment, that can include several methodologies to strengthen the core story.

*Work process*

The first phase of the project development is the elaboration of a **prototype** which goes beyond an annotated outline in the sense that it establishes the line of reasoning from issue identification, via characterisation and analysis to outlook and conclusion. In this way the outline depicted below is merely a first iteration, while further iterations will be available for debate in the working group and at IRP meetings. The prototype will further facilitate interaction with steering committee, strategic partners and broader stakeholder groups. Finally it will facilitate writing of a coherent report via narrative and writing guidelines.

*Chapter 1. Introduction*

[1] Material footprint, material footprint per capita, material footprint per GDP unit, Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP unit.

The introduction describes the objectives and illustrates the contents of the report referring to the logical link between resources as discussed above. Strong reference will be made to the first full GRO report published in 2019 (to stress continuity between the reports). The framing of the report will furthermore allow it to focus on "solutions and benefits of a changed policy", and not just a characterization of problems.

*Chapter 2. Drivers and Pressures*

The second chapter presents and analyses the present state as well as ongoing trends under business as usual conditions of production and use of natural resources. It refers to the corresponding Chapter 2 of the GRO 2019. The presentation of the results comes from different sources, interpretations and, respectively, different frameworks of analysis (paradigms) .

Different types of resources will be analysed: metals and minerals, energy carriers, as well as biomass and water resources. Energy vectors are at the heart of IPCC work, while water has a more local and regional character. As in earlier reports, metals, minerals and the global biomass sector will be presented in more detail. The report will, wherever possible, include a perspective on primary vs. secondary resources.

The report will also analyze resource use from the point of view of some key economic sectors. The choice of these sectors will be guided by the quantitative importance in natural resource flows. Examples of these sectors are nutrition, construction for both infrastructure and housing, as well as mobility.

The analysis of selected resource-type-of-use-systems will further enrich this chapter. The report will be framed around provisioning systems with deep dives into resource management solutions for particularly important systems following a logic of 'servicing human needs for wellbeing'.

Possible topics are:

- Nutrition vs. land use and biological materials
- Energy supply vs. fossil fuels and renewable energy
- Shelter and urban systems vs. construction materials (including timber)
- Manufacturing vs. metals and plastics
- Bioeconomy and the competition for biomass resources

The concrete set of topics will be decided based on the  above-mentioned prototype.

The chapter will furthermore open the discussion about the temporary and longer term impacts of the pandemic on consumption and production patterns. At the time of writing the full set of consequences will only be partially known. Thus a level of uncertainty means that this topic will be less data driven.

Finally, a stronger regional component with focus on solutions and benefits for developing countries, and a focus on social and equity benefits in general. Countries of particular relevance for resources production or use will be analyzed in more depth.

*Chapter 3.State and Impacts*

This chapter will estimate the environmental pressures and impacts generated from the extraction and processing of these natural resources.This approach provides information about the state of the environment, and about how this changing state generates impacts on human health/well-being and the environment It provides the sense of necessity and legitimacy for a more appropriate management policy with regard to natural resources. A starting point, however, is that resource use in itself is not problematic. It brings development and prosperity.

The negative effects to be avoided and the positive potential to be exploited are related to the categories already mentioned above and following the three pillars of sustainability:

- Environmental impacts of extraction, transformation and resources use, in addition to the effect they have on well-being and the sustainability of social communities. This can include references to the biodiversity loss and associated land and soil impacts attributed to in particular land-use changes;
- Inequalities and asymmetries generated by the use of resources between regions or populations. These aspects are covered amongst others in work streams on migration and can provide a novel input to the debate on the consequence of our resource consumption. This also include reference to work on resource sufficiency as a supplement to the efficiency lens;
- Negative economic impact of current practices, but also benefits associated to an increased efficiency of natural resource use.

The identified impact footprints will be linked to different aspects of the desired development, as described by objectives and specific results of the SDG system, in particular those related to the global use of natural resources.

The chapter will also address the nexus between various impact footprints (Climate Change – Biodiversity – Human health/Pollution – Water stress) and assess tradeoffs between these footprints. The estimated footprints will be calculated in a format that will allow further dissagregation by country and by region.

In terms of content, the working group will update the modeling of the power, steel and other metals, cement, and chemical sectors, and will track impacts throughout the whole value chain (including e.g. the impact of fossil fuels or materials in the downstream chain, beyond resource extraction and processing). For the impact footprinting methodology, the modeling of human health and pollution, water stress, and land-use related biodiversity loss will be further improved.

*Chapter 4. Scenarios for a Sustainable Future*

This Chapter has the task of illustrating different resource policy scenarios. The scenarios vary from those that explicitly explain the baseline without interventions (BAU) to those that reach the goals defined in the response chapter. This will include a perspective on stocks and flows of materials and their implications, circular economy perspectives, social aspects and human needs, sustainable consumption and production, transition pathways, and scenario modelling. A further perspective to explore is a new economic model and new (dematerialized) provisioning systems of societal functions and wellbeing, e.g. smart urban systems.

The modelling and calculation of the scenarios is done through the "IRP Modelling Scenario” project. The final scoping of this section will follow the ToR for the scenarios work.

The scenarios developed for this chapter will be informed by the scientific findings of the IRP workstream on Science-Based Targets, as available and where relevant.

*Chapter 5. Response*

Chapter 5 focuses on supporting and accompanying the transformation of the resource production and consumption system, providing where possible and relevant, examples of concrete goals to be reached within a time schedule and potential policy options.

The goals have to be related to objectives 8.4 and 12.2 of the SDGs. As the goal 8.4 description suggests, there may be a need for a temporary differentiation between states at different levels of development and well-being, but with the view of convergence towards an “efficient resource use" which is globally defined.

An important challenge from a conceptual viewpoint is the exploration of possible indicators or indicator systems in order to express these paths and to allow them to be controlled. The starting points are the indicators proposed in the SDG system, but also the growing literature that we can already find in some IRP reports.

We can distinguish response options with a cross-cutting character and measures specific to different sectors, as was done in GRO 2019. It is also possible to distinguish between voluntary technical and organizational measures from public policies often linked to a specific legislation.

Themes that can be addressed will draw on ongoing IRP activities and can include:

- Mineral resource governance. This will support the process that was kicked off at UNEA-4 with the passing of a resolution based partly on IRP work on governance;
- Draw on the scientific findings of the IRP workstream on Science-Based Targets, as available and relevant;
- Innovation and how that has supported higher resource efficiency, but often balanced by rebound effect;
- Circular Economy policy frameworks that enable a transition to sustainable consumption and production. A further aspect linked to this is the application of sectoral policies versus cross cutting frameworks. Most policies are sectoral by nature, while the need for integration is stressed, but often not achieved;
- Transformation of the finance sector and the importance of establishing a sustainable financial business model.

The list of possible measures will always be incomplete and will be developed from one report to the other. Independently of the structure, it is important that the illustrated and proposed actions are described as a toolbox where to collect the most appropriate instrument for each specific case.

*Chapter 6. Policy implications – summary for policy makers*

The role of the IRP is to support and underpin policy debate and as such the report needs to provide a complete narrative on the role of material resources in development and welfare of people and planet. This chapter draws conclusions based on the analysis above. It will be written with the intention of being able to stand alone as the concluding part of a summary for policy makers and will as such need to draw on the full body of evidence.

Relevant themes:

- Point to policy levers with the most potential, most urgent actions considering development trajectories and potential tipping points of the next decade;
- Provisioning systems with deep dives into resource management solutions for particularly important systems; others called it a logic of ‘servicing human needs for wellbeing’;
- The role of the digital economy for transitions and innovation capacity was underlined, and the mineral resource governance challenge;
- Support the further integration of a resouirce perspective in fulfilling global nature pledges, e.g. at the UN Biodiversity Summit, and include a resource perspective in metrics like the UNDP Human Development Index;
- Controversial and complex resource related questions (e.g. ‘efficiency vs sufficiency’; sustainable consumption; equity and per capita resource consumption, etc);
- Support a better understanding of the regional perspective, and in particular the developing/developed country perspective.

*Annex 1: Case Studies*

Annex 1 may contain a series of case studies that refer to specific resources, to defined regions and individual economic sectors. The selection is made on the basis of the working group members and authors' proposals.

While it is not yet clear what the theme of UNEA-6 will be, case studies could be used to support deliberations at the Assemby under that theme.

*Annex 2: Data*

The data used for modelling will be publicly available. The modalities must be established.

## 5. Scale of potential impact and beneficiaries

The report will be delivered directly (likely as an Information Note) to the Sixth Session of the United Nations Environment Assembly (likely February 2023). This is because it represent a direct response to a request from UNEA 4.

As such it will build on the strength of the previous report, and on the greater coherence in the global assessment process as highlighted via a joint session on global assessments and UNEA 4. It will furthermore add weight to discussions around the role of resources in meeting global climate and biodiversity goals and the UN process towards a mineral resource governance framework.

The ambition is clearly to illustrate the need to addres resource consumption as a means to deliver on global goals and not exceed planetary boundaries.

## 6. Engagement of Target Audiences, Outreach and Dissemination

Communication is critical to achieve the impact that the IRP seeks. The ongoing involvement of steering committe, strategic partners and other stakeholders is therefore a vehicle to both ensure relevant and expectation. The report will provide a series of case studies on individual economic sectors, on individual regions and on specific resource types. These case studies can be useful to make the topics presented in the main part of the report concrete and understandable (especially for sectoral ministries and stakeholders).

Specifically, the report is addressed to UNEA. However, it will be designed based on a user-oriented structure of documents and products targeted towards specific communities: public policy and administration, non-governmental organizations and private enterprises, industrial sectors and the economic community, and lastly the scientific community in order to advise them about specific topics to investigate further.

Therefore, the report will have a specific focus on communication, and will formulate a communication and outreach strategy, including the identification of stakeholders to reach, and the preparation of specific media products for the different groups.

The communication on the project should involve different actors: politicians and administration, civil society, economics and science. Specific documents will be prepared for each target group.

One of the goals of the communication activities will be to invite the actors to reflect about the consequences of the transition in their case, as well as about their possible contribution to it. The IRP will facilitate exchange between the actors and support the exchange of experiences

through its reports. The IRP may also be invited by countries or other institutions to monitor specific aspects of their specific transition towards natural resources efficiency.

*Process to engage target audiences*

The GRO23 process will engage target audiences during the production of the report, as well as for and after the launch to:

1. Make sure the core narrative is relevant to target audiences.
2. Make sure the evidence and outputs are useful and clear for target audiences
3. Create ownership and awareness
4. Create early support for the dissemination of the report.

As part of this process, the GRO 2023 working group will reach out to the IRP Steering Committee, IRP Strategic Partners and other key stakeholders. The engagement process will include bilateral interviews as well as workshops and it will try to align with efforts of the Ad hoc Global Assessment Dialogue (convened by UNEP) and the 'Group of Friends for SCP' convened by the 10YFP. Further details on the engagement process of target audiences will be shared upon completion of the 'protoype' of the report.

## 7. Proposed Lead Authors and contributors

The development of content should be seen as an iterative process where the ToR is a first step. This will be followed by a rather detailed prototype, which goes well beyond an annotated outline by establishing the line of reasoning through the report. This prototype can then be used as basis for more detailed consultation and finally allow for an efficient final drafting of the report.

The prototype will also serve as writing guideline in the sense that it clearly outlines what goes into which sections, and what does not.

Each chapter will have one lead, who will liaise with the overall coordinatorcoordination author in charge of doing final drafting to ensure a consistent style and language.

Overall Coordination: Hans Bruyninckx

Chapter 1: *Introduction*
Lead coordinating author: Hans Bruyninckx

Chapter 2: *Driver, Pressure and State*
Lead author: Heinz Schandl
Contributors: to be confirmed by lead author

Chapter 3: *Impact*
Lead author: Stefanie Hellweg
Contributors: : Paul Ekins and others to be confirmed by lead author

Chapter 4: *Scenarios for a Sustainable Future*
Lead author: Steve Hatfield-Dodds
Contributors: Michael Obersteiner, Heinz Schandl, Paul Ekins and Ester van der Voet.

Chapter 5: *Response*
Lead author: Hans Bruyninckx
Contributors: Michael Obersteiner, Stephanie Hellweg, Paul Ekins, Helga Weisz, and others to be confirmed by lead author

Chapter 6: Policy implications – summary for policy makers
Lead author: Hans Bruyninckx
Contributors: to be confirmed by lead author

Annex 1: *Case Studies*
Lead author: Lead authors of all chapters

Annex 2: *Data*
Lead author: Lead authors of all chapters

## 8. Work plan and timeline

| 2020 | | 2021 | | | | 2022 | | | | 2023 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| PHASE I: Foundations & Baseline Analysis | | | | PHASE II: Update, Dissagregated & Special Analysis | | | | PHASE III (GRO 2023 Product Development) | | PHASE IV (launch & outreach) | | | |
| Develop framework, agree on building blocks and scope [material and resource flows - environmental Impacts - scenarios - policy analysis] | | | | | GRO 2019 update | | | Consolidated Analysis and GRO 2023 Development | | Outreach & Communications | | | |
| | | | | | Dissagregated analysis by income / country | | | | Publishing process | | | | |
| | | | | | Regional or Sectoral Assessments | | | | | | | | |
| | | | | | Policy Impact Analysis | | | Develop outreach products | | | | | |
| | | | | | Development of Special Feature Issue | | | | | | | | |
| Scoping meeting | Scoping Document | | ToRs | Prototype Document | 2022-2025 IRP WP | | | First draft | Second Draft | | | | |

## 9. Financial and team requirements

With the aim of ensuring that GRO further strengthens the IRP profile as a leading assessmenrt organization there is a need to secure sufficient funding for flanking activities around communication and outreach, stakeholder engagement, etc. Such elements are not covered in the below budget, as it is considered IRP cross cutting activities.

| **Task** | **Budget (USD)** |
|---|---|
| Coordination with other work streams | 50,000 |
| Development of the Report Content | 300,000 |
| Development of other Outreach Documents | 30,000 |
| 2 x Working Group Meetings | 50,000 |
| Publishing: editing, design | 20,000 |
| **TOTAL** | **450,000** |

## 10. Risks

a. Coordination between projects
GRO 2023 relies significantly on other IRP activities and coordination is therefore essential. Coordination with the "IRP Scenario modelling" has been on-going since the inception of this activity as it significantly feeds into the GRO process.

b. Coordination with similar and independent activities of IRP
The GRO process will overlap with the development of a new IRP strategy. As such it is not yet possible to foresee all relevant interfaces. This will need to be addressed over time. Equally the cross reading between IPCC, IPBES and GRO will need to be strengthened so that consistency in messaging is achieved where relevant, or differences explained.

# Approved ToR under HIPA2: Sustainable Resource Management for effective action on climate change, biodiversity and pollution

## 5. Advancing the Circular Economy in Consumer Electronic Markets[1]

**TERMS OF REFERENCE**

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*[2] investigates the potential for industrial circularization through the lens of value-retention—the notion that circular models are naturally 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

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[1]These Terms of Reference were approved by email in Feb 2021. The notification of the approval, together with the final ToR, were sent on 27 April 2021.

[2] 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.

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 decoule 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 widely recognized as a viable means to achieve this end. However, scientific analysis of barriers and opportunities as a foundation for 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 necessity 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. This can also be of value in providing objective recommendation that can be of value to consumers.

## 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.[1] 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)[2], greenhouse gas (GHG) emissions (793 MMT $CO_2$e per year and growing)[3], 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. Unchecked persistence of linear industrial models will almost certainly impede sustainable development and increase global socioeconomic risks associated with climate change.

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 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.

[1] 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

[2] 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.

[3] 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

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[1], 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

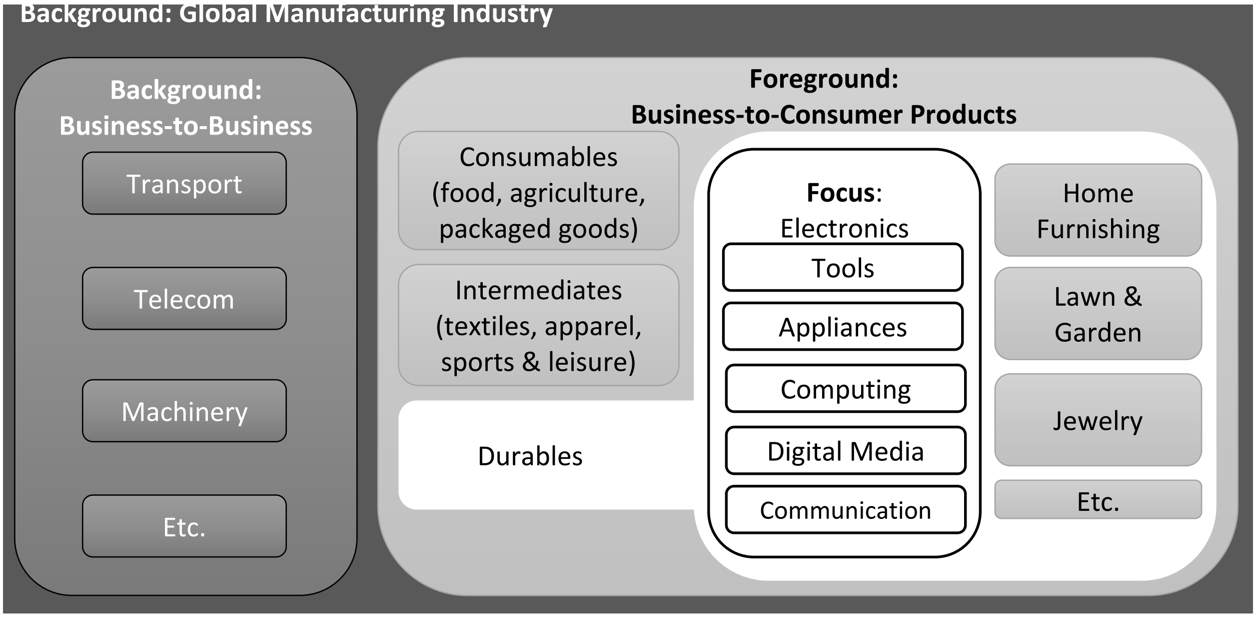

***Figure 1:*** *Project scope relative to broader industry. Example categories highlighted are illustrative; definitive product categorization & selection will be a product of Part I of the study outlined below.*

unaddressed.

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 technology 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 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).

[1] 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

*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<br><br>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 commercial-grade electrical and electronic equipment.

### 3. 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 a representative nation with growing involvement in secondary CEP handling and representation of major emerging markets in the global landscape. Case nations from Africa (e.g. Ghana), Southeast Asia (e.g. the Republic of the Philippines), or China may all be suitable for this role.[1]

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 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 tools developed for this study will be designed to maximize usability.

## 4. Value Retention Processes

The 2018 IRP report on *Redefining Value*[11] 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[2] 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** (Appendix II, UNEP/CHW.13/4): ): Modification of used or waste equipment to increase or restore its performance and/or functionality or to meet applicable technical standards or 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.

[1] Final selection of case nations will be subject to data availability, policy relevance, and Panel approval.
[2] A used product or part intended to be remanufactured. During reverse logistics, cores are identified for remanufacturing and handled to avoid damage and preserve value. A core is not waste or scrap and will not be reused prior to remanufacturing.

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.

While 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.

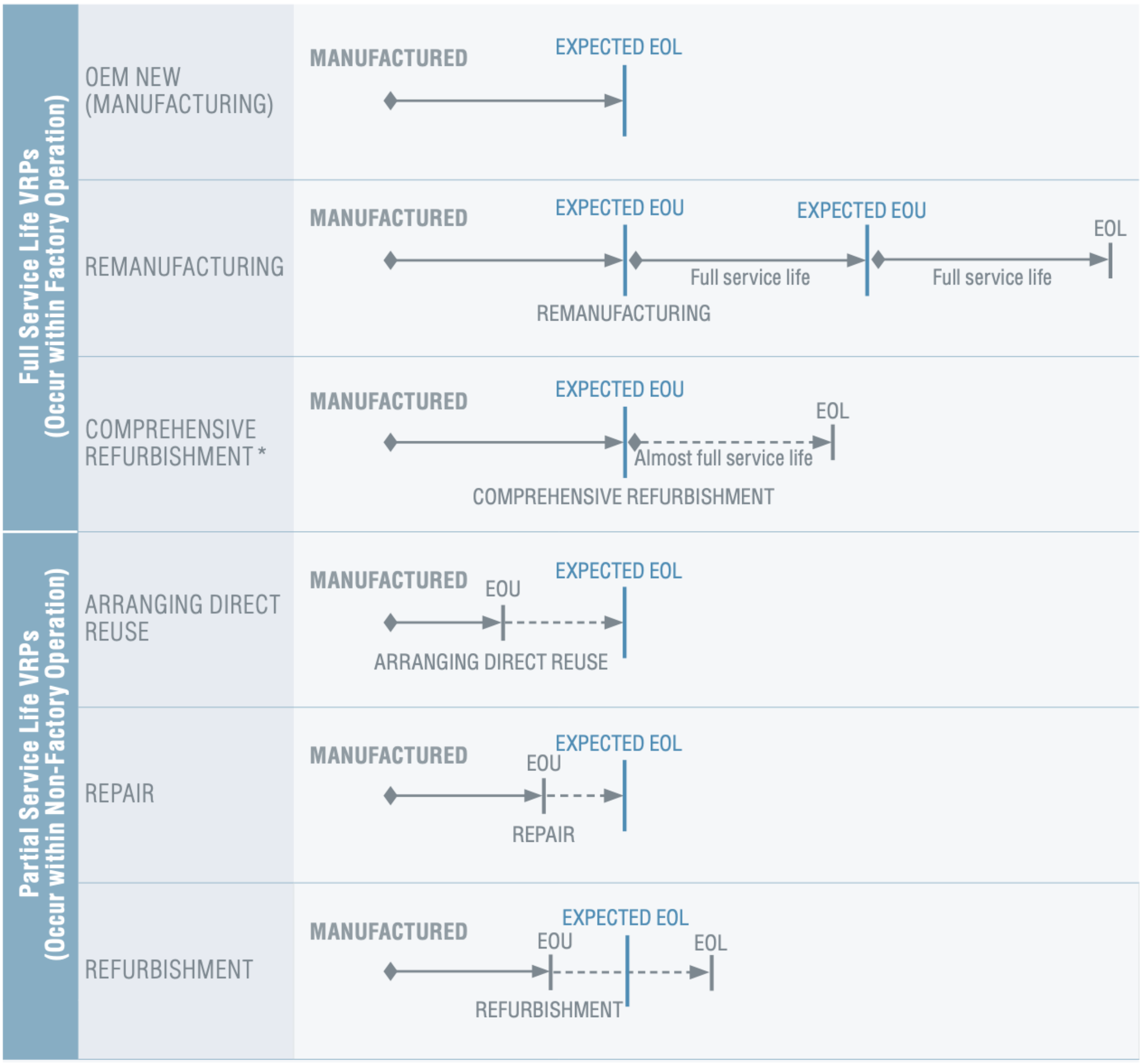


***Figure 2:*** *VRPs by point of deployment relative to end-of-use [EOU] and effect on service life, adapted from IRP (2018).*

## 5. 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 the circular economy, the proposed approach of this study is comprised of five key parts in ascending order of complexity and scale.

### 5.1. Part I: Market Assessment & Data 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) 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. Market data on volume (# units), value ($USD), and impacts (material, energy, waste, and emissions) will reveal key opportunities to optimize returns on investing in circular shifts. 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.

### 5.2. 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 CEP sectors 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. This investigation 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.

### 5.3. 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 such barriers might affect uptake.** Bottom-up lifecycle accounting of costs, inputs, energy, materials, and emissions will create a unit-process data inventory for each VRP case model. 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 drivers and barriers—in 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 these characterizations is consideration for the relationships between VRPs and net product use, which significantly affects net environmental impact. Analysis of these characterizations will illustrate which drivers and barriers have the greatest influence over material reuse potential and, by extension, 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.

### 5.4. **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 parameters and levels of barrier alleviation affect VRP case model uptake and impacts, and thus shed light on the costs, benefits, and technical feasibility of achieving future states of resource efficiency and circularity. 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.

### 5.5. **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 environtmental impact assessments to the industry scale for each case nation using input/output modeling, 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 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. 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 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.

### 5.6. 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.

**6. 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 holistic 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.

**7. 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:

**8. 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 circular 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

**9. 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.

**10. 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.

**11. 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 in general and the challenge of the circular economy at large.

**Part I: Market Assessment & Data Analysis** (10 pages)

- Research Questions
    - What are the most important product sectors/classes in the consumer electronics market?

    - How do the most important sectors differ across developed and developing nations?
- Potential Contributors: Seiji Hashimoto, Anthony Chiu, Bing Zhu, Ester van der Voet

**Part II: Identification of Potential VRP Scenarios** (15 pages)

- Research Questions
    - What kinds of VRP models are applicable to CEP markets?
    - What functional adaptations would enable implementation in case product categories?
- Potential Contributors: RIT, Mitsutaka Matsumoto, Bing Zhu, Markus Reuter, Antoinette van Schaik

**Part III: Scenario & 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 can be learned from cases where VRPs are already successful?
    - What prevents integration and growth in circular economy strategies?
        - E.g. material management regulation, core availability, use cycle and durability characteristics, market interest and acceptance, OEM-third party relationships
    - What changes are necessary to grow market access for VRPs, and what might the benefits be?
- Potential Contributors: RIT, Mitsutaka Matsumoto, Markus Reuter, Antoinette van Schaik, Stefan Bringezu

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

- Research Questions:
    - How do VRP scenarios perform under different conditions of potential barrier alleviation, and what are the benefits in resource efficiency and economics at the product and firm level?
    - What changes (in design, technology, logistics, policy, and use/ownership models) offer the greatest return in enabling circularity, in terms of uptake and net benefits?
- Potential Contributors: RIT, Edgar Hertwich

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

12. **Research Question:**
    - How does VRP uptake affect economics and environmental performance across industrial structures?
- 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 in technology, logistics, and market enablers that most influence environmental and economic outcomes of VRP uptake in CEP sectors?

- What policy measures in technology development, producer responsibility, market structure, international trade, etc. can be used to create favorable enabler conditions?
    - What types of actions and relationships are required to develop and deploy such policy measures?
- Potential Contributors: Hans Bruyninckx, Peder Jensen, broader group discussion, private sector consultancy group

**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.

13. **Workplan and Timeline**

| **Tasks** | **Target** (Months) | **Status** (Dec. 2020) |
|---|---|---|
| Establish working groups & coordinate expert inputs | August 2020 | Complete |
| Market Assessment and Data Analysis | Months 1-3 | - |
| Indentification 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 | - |

14. **Budget**

| Budget | | | | | |
|---|---|---|---|---|---|
| **Activity** | **Quantity in year 1** | **Quantity in year 2** | **Unit** | **Unit Cost (USD)** | **Total Cost (USD)** |
| **Activity 1 –** Development of an assessment report and related sub-products | | | | | |
| Technical Support (UN fee table, Level C) for the following deliverables: | | | | | |
| - Establish working groups and coordinate expert inputs | 15 | 15 | | | $8,610 |
| - Market Assessment and Data Analysis | 45 | 0 | | | $12,915 |
| - Identification of VRP Case Models | 57 | 0 | | | $16,359 |
| - VRP Case Model and Barrier Analysis | 72 | 0 | | | $20,664 |
| - Barrier Alleviation & Uptake Modeling | 120 | 0 | | | $34,440 |
| - Economic & Environmental Implications | 28 | 42 | | | $20,090 |
| - Policy Analysis & Recommendations | 0 | 91 | Person day | $287 | $26,117 |
| - First draft assessment report ready for peer review | 0 | 146 | | | $41,902 |
| - Peer review feedback and discussion | 0 | 13 | | | $3,731 |
| - Final version of assessment report addressing peer review comments | 0 | 49 | | | $14,063 |
| - Final version of summary for policy makers | 0 | 34 | | | $9,758 |
| - Final version of summary for business leaders | 0 | 11 | | | $3,157 |
| - Final version of factsheet | 0 | 9 | | | $2,583 |
| - Power point presentation of findings | 0 | 9 | | | $2,583 |
| **Sub-total** | | | | | **$216,972** |
| **Activity 2 –** Organization of consultative stakeholder meetings | | | | | |
| - Travel of 10 international participants (1 day meeting in Ghana) | 10 | | Ticket price | $1,500 | $15,000 |
| - DSA for Ghana for 10 sponsored participants for 1 day | 10 | | Participant/ day | $300 | $3,000 |
| - Travel of 10 participants (1 day meeting in Washington DC, 6 international participants + 4 national participants) | | 6 | Ticket price | $1,500 | $9,000 |
| | | 4 | Ticket price | $500 | $2,000 |
| - DSA for Washington DC for 10 sponsored participants for 1 day | | 10 | Participant/ day | $335 | $3,350 |
| **Sub-total** | | | | | **$32,350** |
| **Total Cost** | | | | | **$249,322** |

## 15. Existing Research

### 15.1. Market Assessment & Data 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.

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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

Huisman, J., Habib, H., Brechu, M. G., Downes, S., Herreras, L., Lovik, A. N., Wager, P., Cassard, D., Tertre, F., Mahlitz, P., Rotter, S., Chancerel, P., Soderman, M. L., Guzman Brechu, M., Downes, S., Herreras, L., Loevik, A., Wäger, P., Cassard, D., … Chancerel, P. (2016). ProSUM: Prospecting Secondary raw materials in the Urban mine and Mining wastes. Systematic harmonisation and classification of data sources for mapping EU secondary raw materials in Electronics, Batteries, Vehicles and Mining Waste. Proceedings Electronics Goes Green 2016+, 1–8. https://doi.org/10.1109/EGG.2016.7829826

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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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### 15.2. Identification of Potential VRP Models & Scenarios

TBD

### 15.3. Systems Analysis & 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.

### 15.4. VRP Uptake Scenario 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

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# Approved ToRs under HIPA3: Sustainable Resource Management for effective action on human health, well-being, prosperity and equity

## 6. Transition to a Resource Efficient Economy

### Terms of Reference[18]

| |
|---|
| **Purpose of the study**<br>The primary purpose of this Think Piece is to express and present the International Resource Panel's (IRP) conception of a transition to a more sustainable and equitable world.<br><br>**Background and current status**<br>Two separate groups will develop, in parallel, two distinctive draft think pieces providing the IRP's insights on how to transition to a resource efficient and zero carbon / carbon neutral economy.. The two think pieces will differ in their selected focus and primary target audience. The first group, co-led by Eeva Primmer and Hans Bruyninckx, will follow a policy-oriented approach conveying policy implications to support a sustainability transition, with relevant policy-makers as the key target audience. The second group, co-led by Mark Swilling and Helga Weisz, will favour a more theoretical/social scientific approach covering the literature on sustainability transitions, with Panel and IRP Steering Committee members being the main target audience. The latter think piece will seek to provide a foundational transition narrative to support the ongoing IRP 2021 Strategic Planning Exercise.<br><br>Working group meetings were held in July 2020 and September 2020 and each group has submitted its respective final think piece proposal. The two proposals are submitted jointly to the Panel Co-Chairs for their review and approval, as appropriate.<br><br>Once the joint proposal has been approved, the two groups will work in parallel over the period of one year to develop the think pieces. The originally approved budget devoted to this workstream is USD 125,000. Both groups will interact with each other in drafting their respective think piece.<br><br>Once the initial drafts are developed, a sub-group of working group members can determine whether the two draft think pieces could be reconciled as one, or whether they would stand as separate pieces. In the latter case, the policy-oriented think piece will be published and disseminated to policy-makers and other stakeholders. The more theoretical piece may also be published but it will primarily be used for internal purposes to inform the work of the Panel and the next IRP Work Programme for 2022-2025.<br><br>**Expected outcome(s)**<br>Approval of joint think piece proposal |
| **References:**<br>According to IRP Policies and Procedures, Section IV Scientific Publications, paragraph:<br>*72. The following are the main categories of IRP scientific publications: ...(d) Think Piece: A technical or policy paper based on IRP scientific studies and assessments and other relevant literature, on topics related to the IRP's objective for which a scientific perspective is deemed essential. A Think Piece is not a full study and assessment but science-based reflections, which may catalyze the generation of new scientific knowledge or highlight critical topics to be considered in policy discourse. A Think Piece may be published in academic journals and online platforms. It is* |

[18] The proposal was approved by Panel Co-Chairs in March 2021.

*prepared in less than 1 year.*
Further, under Section IV.4. the procedures for preparing a are outlined, including:
1. A Think Piece is not subject to the preparation and clearance process outlined in paragraphs 73(a), 73(b), 73(c), 73(d), and 73(e) of these procedures.
2. A Think Piece may be proposed at any moment by an IRP member.
3. The Think Piece proposal is approved by Panel Co-Chairs.
4. Panel members, with the support of the Secretariat, prepare and submit the Think Piece to the Panel and Steering Committee for input and recommendations.
5. Panel and Steering Committee Co-Chairs approve for publication.

**IRP Think Piece Proposal A (policy driven)**

**Governing sustainability transitions in a resource dependent world**

**Submitted by: Eeva Primmer and Hans Bruyninckx**

## 1. Purpose

The shift from resource-intensive socio-economic systems to ones that function within planetary boundaries requires a socio-metabolic transition that fundamentally reframes material use, consumption, markets and institutions. The proposed think piece is grounded in an understanding that existing policy approaches to resource governance are often inadequate because they fail to address the underlying systems driving unsustainable resource use.

On this basis, the think piece has two main aims:

- first, to explain and demonstrate how using a systemic, transition-oriented framing can help in understanding the barriers to sustainable resource governance;
- second, outline how policies as well as specific policy mixes can address these barriers and foster the systemic transitions that are needed to achieve sustainable resource use.

The think piece will use existing IRP knowledge, supplemented by additional examples and cases from different world regions, to illustrate the limitations of prevailing approaches to resource governance and the implications of embracing transitions thinking for resource policy and governance.

The think piece is targeted, in particular, at policy audiences. By combining and synthesising transitions knowledge, it will help in designing policies, strategies and investments that can transform production-consumption systems and deliver on the Sustainable Development Goals (SDGs). It will address policies that seek to improve sustainability and policies in which sustainability is traditionally not at centre stage (e.g. labour market policies).

By turning the assumed and implemented modes of policy intervention into an empirical question, the analysis will help stimulate reflections within the IRP on the analytical frameworks used in its assessments of sustainable resource governance and related policy guidance.

**2. Relationship with the IRP objective and strategy of the corresponding cycle**

This think piece contributes to work area 3.3.1 'Transitions to a resource-efficient economy' in the IRP Work Programme 2018-2021. It will draw on and leverage previous IRP reports as sources of evidence about resource-intensive value chains, socio-economic and environmental impacts, and governance challenges and responses.

**3. Scope**

The think piece will synthesise and interpret existing knowledge in relevant IRP reports and other literature. As a short product (c. 10,000 words), it is not intended as a research report. Instead, it will begin by providing a brief and illustrative presentation of the problems that traditional policy approaches encounter when addressing sustainable resource governance. The think piece will then outline the potential benefits a sustainability transitions framing can provide to resource governance.

**4. Structure**

The think piece is expected to be structured as follows:

**Foreword**

- This will address the high expectations placed on transition and transformation approaches in recent global assessments and policy documents, and the challenges in implementing these goals in governance settings organised by sectors

**Executive summary**

**Chapter 1: Persistent problems with global resource governance**

- This introductory chapter will present the persistent and growing problem of unsustainable global resource use across the entire value chain, which points to the need for new governance approaches.
- The content for this chapter will be largely drawn from existing and relevant IRP assessments.

**Chapter 2: Challenges for governing sustainable resource management and use**

- This chapter will describe the systemic nature of resource governance challenges (IRP, 2019), in particular the ways in which feedbacks and interactions within complex systems hinder sustainability enhancing governance by creating lock-ins, uncertainties, unintended outcomes and policy failures. As in recent European Environment Agency assessments (e.g. EEA, 2019a), the chapter will make the discussion tangible by describing several illustrative resource-intensive systems from different world regions, linking resource flows to other elements such as investments, jobs, technologies, behaviours and institutions. The aim of this mapping is to convey the complexity, diversity and interdependence of the systems and their sustainability implications.
- The discussion will also show how the co-evolution of different elements within systems produces barriers to change. The different types of lock-ins, barriers, etc. will be further illustrated using exemplary cases (including, but not limited to, the mining sector; the agri-food sector and critical raw materials linked to the energy sector).
- The chapter will also highlight existing policy approaches/paradigms, policy mixes and instruments (see e.g., Fitch-Roy, et al. 2020), their the limitations in natural resource governance and present the case for a sustainability transitions/transformative innovation approach to natural resource governance (e.g., Schot and Steinmueller, 2018).

**Chapter 3 Opportunities for catalysing and supporting sustainability transition**

- This chapter will summarise concepts from sustainability transitions research on change processes in complex societal systems as well as the ways in which public policies and institutions can help trigger and orient such change.
- It will illustrate how these lessons can be transferred to address different resource flows. This will include a brief discussion of the ways in which disruptive shocks (e.g. COVID-19, the financial crisis, natural disasters) can create opportunities for systemic change; the role of policy in supporting diverse forms of innovations (social, technical, business models, etc.) in creating new ways for society to meet its needs, and the critical role of networks, intermediary actors, platforms and finance in enabling innovations to emerge and spread. It will also include the role of policy and policy mixes in the purposeful and just disincentivising and/or phase-out of current resource intensive and inefficient systems.
- The assessment of policy and its transition impacts will extend beyond a presentation of transformative (goal-oriented) innovation policy to outline how all parts of government need to be engaged in enabling and orienting systemic change. It will present current approaches to the various cross-cutting challenges for governance, including the need for directionality (Weber and Rohracher, 2012), policy coherence (OECD, 2019), and new knowledge and skills that are identified in Chapter 2. It could also include reflections on how to enable and combine hierarchical, market and network styles of governance.
- Like chapter 2, the assessment will use brief cases and examples from different world regions throughout to illustrate and explain successful sustainability transition interventions, for example, on successful government interventions to

support the emergence and diffusion of sustainable technologies and practices (e.g. clean energy or organic food) or policy support to ensure that structural economic change produces fair outcomes (e.g. enabling transitions in coal regions).

**Chapter 4: Summary and reflections**

- This brief chapter will provide a set of overarching messages for resource policy and governance. These will probably include reflections on the similarities and differences in the analytical and governance challenges in different regions (e.g. developing v. developed regions) and resource using and managing systems.
- It would also set out possible implications of the think piece for future IRP work and priority areas for further research.

## 5. Urgency

The think piece, and its focus on the role of policy and policy mixes in enabling systemic transitions toward more sustainable resource governance, has the potential to feed into the framing of policy advice in the next IRP Global Resource Outlook 2023 and it will speak to several other global UN led processes that have recently called for sustainability transition, including those on SDGs, climate, biodiversity and ecosystem services .

## 6. Complexity

The think piece aims to explain the complex, yet broad research fields that encompass complex systems, transitions and policy implications in simple and accessible terms that are targeted at a policy audience, illustrating these with examples of resource governance. It will draw on, synthesis and communicate existing research, pointing readers to more detailed analysis in the academic and grey literature.

## 7. Existing knowledge base

The literature on sustainability transitions and transformations has grown rapidly during the last two decades. This think piece will specifically draw on recent conceptual work in the field that has focused on the role of public policy in steering transitions (Edmondson et al. 2019; Kivimaa and Kern 2016). It will also draw non-academic literature produced, for example, by the UN (2019), UNEP (2019), ILO (2015), OECD (2016) and EEA (2019 a,b,c), which offer frameworks for translating transitions approaches to policy audiences. This framework will be tailored to the needs of the think piece, taking into consideration the global diversity of sustainability challenges, governance contexts and social justice considerations.[19]

[19] Relevant literature to draw upon includes Puplampu and Hanson (2017); and NRGI (2017).

Empirically, the think piece will draw on the existing knowledge base of the IRP (e.g. IRP reports[20]), supplementing this with literature to obtain relevant empirical cases and a broad geographic scope.

**8. Policy relevant questions**

- How and why are existing modes of governance failing to address the unsustainable use of natural resources?
- How can a sustainability transitions framing for assessments and policy design support the shift to more sustainable modes of resource governance?

**9. Added value**

This think piece will provide a synthesis of resource governance policies highlighted in previous IRP reports, and situates these policy recommendations in the broader context of transitions governance, i.e. the policy mixes that are needed to facilitate the transition to sustainable resource management. This analysis will also shed light on blind spots in current resource governance approaches, thus highlighting policy and governance dimensions that must be addressed if sustainability improvements in complex resource flows are to be enacted. The piece is novel in that it shifts the application of transition approaches from socio-technical systems to a much more direct focus on resource flows. It thereby dovetails with the existing IRP knowledge base.

**10. Proposed lead authors**

Eeva Primmer (IRP Panel member) and Hans Bruyninckx (IRP Panel member).

**11. Available expertise**

The IRP has a number of panellists capable of contributing to this work. Eeva Primmer and Hans Bruyninckx (IRP members), will lead the report. IRP panellists (including but not limited to Anthony Chiu, Maarten Hajer, Antonio Pedro) will support this work by contributing to the analysis of cases that ensure a broad empirical and geographic coverage. Mike Asquith (European Environment Agency) and David Lazarevic (Finnish Environment Institute) have expertise in sustainability transitions and innovation policy and will support the panellists in their work.

**12. Financial requirements**

[20] A review of IRP reports will be conducted focusing specific on policy approached and options detailed. This will provide an overview of how policy has been addressed in the IRP corpus.

| Item | Amount (USD) |
|---|---|
| Technical inputs (researcher salary) (SYKE) | 24,000 |
| Technical inputs (legally required social fees for hiring researcher) (SYKE) | 12,000 |
| Technical inputs (overhead costs) (SYKE) | 24,000 |
| Travel | 5,000 |
| Publication and communication | 15,000 |
| **Total** | **80,000** |

**13. Work plan, including schedule**

- Meetings, workshops
  - among working group – 4/2021 (focusing on challenge), 6/2021 (focusing on opportunities), 9/2021 (focusing on key messages)
  - with more participants, e.g. one to align with the new IRP Work Programme
- A final structure for the work 3/2021
- Feedback and comments from other Transitions Think Piece working group, other panel members - 4/2021
- Draft report 7/2021
- Feedback from Panel members 9/2021
- Final Think Piece report 11/2021
- Publication and outreach by 12/2021

**14. References**


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**IRP Think Piece Proposal B (theory driven)**

**Understanding and governing sustainability transitions in a resource dependent world**

## 1. Purpose and Urgency

The need to recover from an unprecedented pandemic provides a historical opportunity to accelerate the transition to a greener and more just world, a 'transformed world' as envisaged in the Preamble of the Sustainable Development Goals (SDGs). The primary purpose of this think piece is to provide a foundational transition narrative, providing insights as to how a low-carbon and resource efficiency transition can come about. In doing so, it will inform the theory of change of the International Resource Panel (IRP) and provide a common narrative/ understanding of transition dynamics to inform ongoing and future IRP work streams. The timeline for developing the think piece is also planned to ensure that it can support the 2021 IRP's Strategic Planning Exercise (SPE) currently underway to determine the 2022-2025 IRP Work Programme.

Since 2007 the IRP has generated an extensive body of scientific work that effectively advocates for an end to the resource- and carbon-intensive industrial era. IRP reports provide ample evidence and numerous examples of what needs to occur, but little insight into how the global transition could take place.

The primary target audience of this think piece is the IRP itself, including both the scientific experts of the Panel and the members of the Steering Committee. The secondary audience are those experts, NGOs, policy and academic communities interested in sustainability transitions. The IRP is well-placed to influence ongoing debates about a green and just recovery from the Covid-19 pandemic from a resource lens.

## 2. Relation with IRP objective and strategy of the corresponding cycle

The think piece is an approved aspect of the IRP 2018-2021 Programme of Work under HIPA 3: Socioeconomic implications of the transition to more resource efficient economies and societies. As mentioned above, the think piece will inform the 2021 SPE to develop the IRP 2022-2025 Programme.

## 3. Scope and Structure

This think piece aims to understand the complex dynamics of sustainability transition in ways that help the IRP to further develop its theory of change. Specifically, the following topics and questions will be addressed:

1. **Introduction:** Global socio-economic background and relevance for IRP work. The post-Covid-19 recovery creates the opportunity for a sustainability transition. Policy and business leaders express unprecedented commitment to a just and green transition. The challenge is to understand core dynamics that accelerate or prevent a green and just recovery. So far the IRP reports show why we need a transition, but not how it can be achieved. Empirical evidence shows that global commitments to achieve the SDGs and countless local and international initiatives do not add up to a large-scale sustainability-oriented socio-metabolic transition.
2. **Assessment of transition literature**: Does the transition literature help to frame and understand the challenge to understand core dynamics that accelerate or prevent a green and just recovery? There are already comprehensive assessments of the transition literature available (for instance, EEA, 2019a; EEA, 2019b; Swilling, 2019), so the think piece will not repeat this work. It will rather distil from this literature to what extent and how this body of work can help to frame the above mentioned challenge.
3. **IRP's current transition understanding:** What is the transition theory implicitly (or explicitly) incorporated in IRP reports? What roles are envisaged for state, business and civil society actors? What is the relative impact of key change-oriented activities/initiatives such as scientific research, international science panels and fora, entrepreneurial innovations, the digital commons, global agreements, national legislation, cultural change, financial investments and social movement activism? The think piece will pay special attention to the available literature on historical and ongoing socio-metabolic transitions (Boserup 1965, Smil 2008, Wrigley 2010, Mitchell 2011, Grubler 2012, Krausmann et al. 2016, Lenton et al. 2016, Fischer-Kowalski et al. 2019) and the IRP integrated scenario modelling work stream.
4. **Finance and institutions:** What is largely missing in the available transition literature and in IRP reports is the role of finance and institutions. Especially the financial system has been identified as a major missing link in creating the conditions for accelerating a sustainability transition. Since the global financial crisis of 2007-2008, a fast-growing literature has assessed the structure, but also to a limited extend the sustainability implications of the current financial system (UNEP FI 2020[21]; Ellen MacArthur Foundation 2020; Yan et al. 2020), Despite the complexity and dynamics of the financial system, the think piece will endeavour to undertake an initial assessment of the financial system from a sustainable resource use lens. In this we will cooperate closely with the IRP "Finance for Sustainability Minerals Production" work-stream.
5. **Investment and the just transition:** a first synthesis will focus on inequality, resource use and investment criteria, with special reference to the extractive industries, utilizing insights from section 1 to 4.
6. **Governance for transition**: based on this a second synthesis will ask: what are the implications of transition dynamics for the understanding of governance? Given wide agreement that policy-led change will become increasingly more important,

[21] UNEP FI is developing guidance to provide a common framework, indicators, metrics and methodologies to guide banks on target setting on resource efficiency. UNEP FI will release guidance for banks to set targets on resource efficiency and biodiversity in 2021.

how to 'bring the State back in' without reducing complexity or suppressing important market incentives? Policy-led directionality without compromising complexity raises questions about the 'governance of governance', in particular the capacity to facilitate partnering for effectively managing complexity.

7. **Implications for future IRP work:** A third synthesis will be based on selected IRP reports (e.g. IRP, 2018; IRP, 2019; IRP, 2020; UNEP, 2013; UNEP, 2017), and specify new questions that should be addressed by the IRP from a transition perspective. Develop a framework for evaluating the scale and pace of the transition. This framework can, among others, be used as input to IRP work streams on science-based targets and on integrated scenario modelling). Unless the physical scale and the social implications of the socio-metabolic transition are recognized seriously and the incentive structures for financial capital allocation work in favour of a just socio-metabolic transition, the countless initiatives set by governments, companies and NGOs will not add up to the 'transformed world' envisaged in the preamble of the SDGs. The implications of a successful just sustainability transition are not only achieving SDGs and the Paris agreement on climate change, but also massive stranded assets and a large-scale reallocation of wealth and income. While this partly explains the prevailing resistance against strong policies supporting a sustainability transition, the think piece will advocate that stranded assets and more generally losers and winners of a sustainability transition be included as core topics in the next IRP work programme.

## 4. Products

There will be two products. A longer version (approximately 15,000 words) published as an IRP think piece and a shorter version (approximately 7,000 words) published as a perspective paper in a respected scientific journal.

## 5. Complexity

The material that will be synthesized is complex and difficult to manage. However, the necessary expertise exists within the working group.

## 6. Existing knowledge base

On the whole, the knowledge base within the IRP is adequate. This works stream will benefit from exchanges with the IRP work-streams on Finance for the Extractive Industry and on Science-Based Targets.

## 7. Policy relevant questions

The key policy relevant questions that the report will address are as follows:

- What are the deeper underlying longer-term dynamics of transition underway in the world today?
- What are the blind spots in the transition literature and in the IRP work?
- How are actors going about understanding the transition, and in particular the pathways to transition in the future?

**8. Added value**

The IRP has documented the socio-metabolic limits of industrial modernity. It now needs to provide a way of thinking concerning the dynamics of a transition to a more equitable, resource efficient and decarbonized world.

**9. Available expertise**

The proposed IRP working group includes: Mark Swilling and Helga Weisz, as working group leaders, and Antonio Pedro and Maarten Hajer as contributors. Contributors from related IRP work streams will be invited to contribute where necessary. External experts (such as researchers from Stellenbosch University and Humboldt University) will also be engaged to contribute.

**10. Scale of potential impact and beneficiaries**

No-one disagrees with the proposition that the world faces a multiplicity of nested crises; what has been referred to as the 'polycrisis'. This, however, is creating immense uncertainty amongst key constituencies which, in turn, reinforces the positions of those who want to deny the need for a transition. There is a strong demand across most key stakeholders for a counter-narrative that essentially makes sense of the complex dynamics of transition in ways that transform uncertainty from a threat into an opportunity. If this report can be succinct, elegant, clearly articulated, scientifically rigorous and digestible, it will actually stimulate hope. To this extent, it is a report that could make a substantial impact.

**11. Financial and team requirements**

The proposed budget for the think piece is summarized in the table below:

| **Item** | **Amount in USD** |
|---|---:|
| Hiring of research assistant (University of Stellenbosch) | 20,000 |
| Hiring of research assistant (Humboldt University) | 15,000 |
| Travel for one working group meeting | 5,000 |
| Publication, Communication and Outreach | 5,000 |

| Total | 45,000 |
| --- | --- |

**12. Work plan including timeline, outreach and dissemination**

The proposed workplan for developing the think piece is as follows:

- April 2021: contracts signed
- June-July 2021 (subject to ability to travel due to prevailing COVID-19 situation): in-person meeting of working group
- September 2021: Zero draft of think piece submitted to all IRP Panel members for feedback
- March 2022: Final version of the think piece submitted to IRP Co-Chairs for approval and a shorter version to an appropriate scientific journal
- April 2022: Publication

**13. References**


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# 7. Socio-economic Implications of Enhancing Resource Efficiency and Promoting Circular Economy

## Terms of Reference[22]

## 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.

[22] Approved at the 25th Meeting of the IRP on 8 November 2019 (meeting document IRP/25/19).

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[23]. 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[24].

23 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

24 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

## II. Rationale and Purpose

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[25] 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,

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)

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

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 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[26]. 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[27] 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

[26]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.

[27] 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.

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:

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<br>• 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<br>• WTO- Evaluate and re-strategize trade mandates on equity principles, beyond economic efficiency<br>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.<br>• 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 the 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.

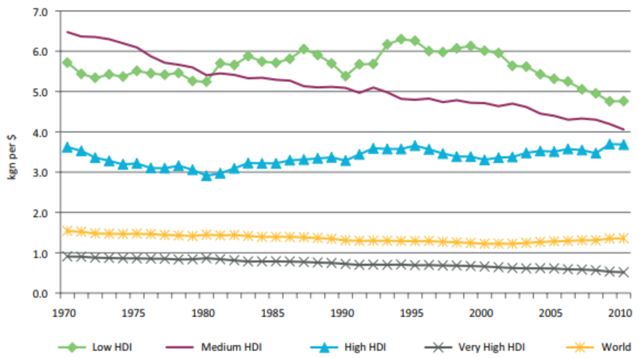


*Figure 3: Material Intensity of economies, as per development status of countries*

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)

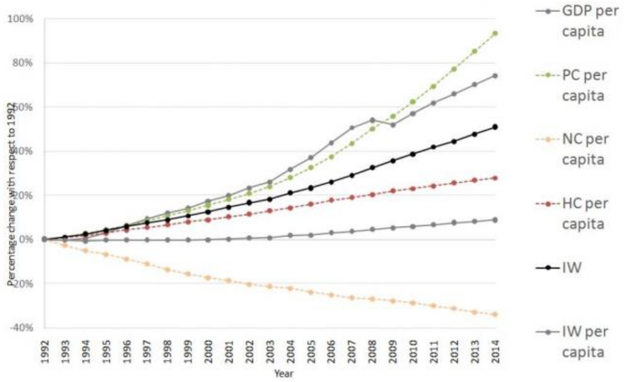


*Figure 4: Inclusive Wealth, Global, 1992-2014*

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-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**

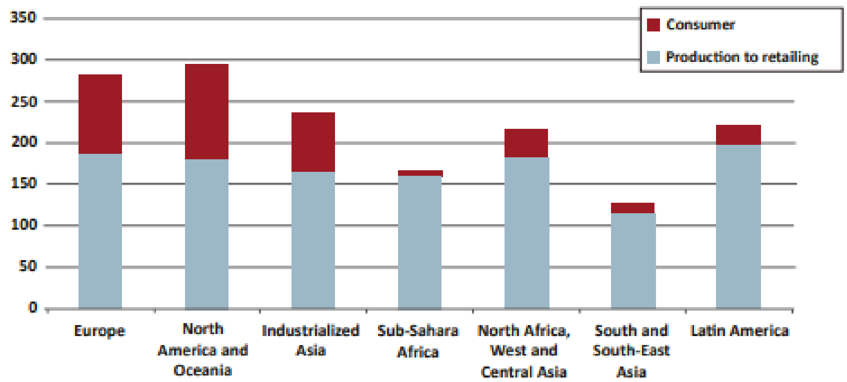


*Figure 5: Per capita food losses and waste, at consumption and pre-consumption stages (kg/year)*

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% upon a Lewis Path (46 nations)

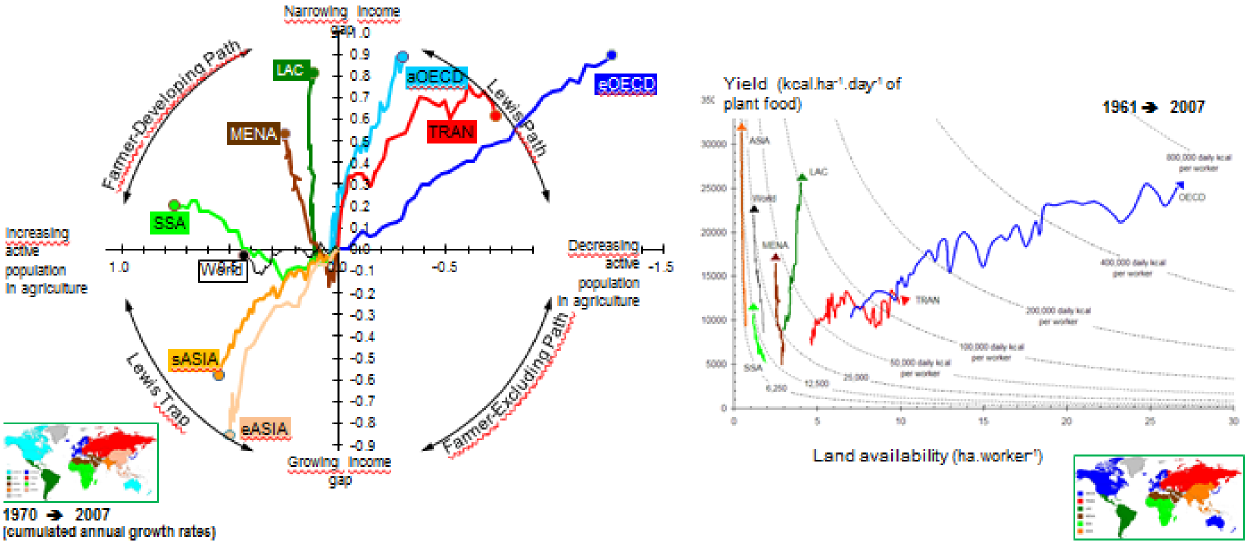


*Figure 6: Labour income gap of Asian farmers widened despite best growth and ranking in yield*

(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.[28]

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). 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

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

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.

## 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<br>• Inter-country comparisons on material footprint/HDI/ Inclusive Wealth<br>• 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[29] | |
|---|---|
| • Resource efficiency – Equity nexus studies in three or four systems: Food Systems, Human Settlements, Manufacturing & Services, Land & Forests.<br>• 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<br>• 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<br>• Market instruments<br>• Governance of resources and production systems<br>(Policy strategies will reflect two types of changes –<br>• Incremental – *that leads to short term improvements*<br>• Systemic / structural – *that leads to long run shifts)*<br>(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<br>• 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 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

[29] 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.

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

## V. 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.)<br>• Efficiency of Resource use – Production Systems and Consumption Patterns<br>• State of Inequities – Access to Resources, Incomes, Wealth<br>• State of Economy – Material Intensity, Income disparities<br>• 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<br>• Factors that enable/inhibit distributional equity of resource efficiency benefits – Historical evidence, potential<br>• Role of international trade/globalisation on distributional equity of resource efficiency<br>(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.<br>Strategies employed in different contexts:<br>• Factors that enable/inhibit equity benefits from resource efficiency strategies<br>• Role of Governance of resources and decision making institutions<br>• Financial, technology and market ecosystem levers identified<br>(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<br>• 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)<br>• Approaches and strategies available to decision makers in different contexts<br>    • The approaches and strategies will be tailored by type of decision maker in line with the target audiences identified for this report<br>    • The report will aim at establishing which approaches and strategies are most needed to solve the key challenges<br>• 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.

## VI. 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.

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

## VIII. 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 opportunitie s 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

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# Approved ToR under HIPA4: Enabling sustainability transitions

## 8. Financing the Extractive Industry to Contribute to the Achievement of the SDGs

**TERMS OF REFERENCE[30]**

1. **BACKGROUND**

At the Lima IRP meeting (IRP21, November 2017), as part of the discussions on the High-Impact Priority Area (HIPA) 3, Paul Ekins presented the Concept Note: 3.3.4 Resources and Finance: The Cost of Resource Efficiency and the Finance and Investment System We Want for Transformation.

[30] Approved at the 26th Meeting of the IRP on 23 October 2020 (meeting document No. IRP/26/09).

The meeting expressed strong support for this concept note (European Commission, USA, Germany, Switzerland, Ayuk) and raised the following points during the discussion for consideration by the lead authors:

- That the work should leverage the enormous amount of existing research on clean energy finance and finance for ecosystem services (Lifset), and link to Green Finance and Circular Economy initiatives and discussions in the policy domain (European Commission);
- To link with the United Nations Principles of Responsible Investment (Japan);
- To link the work also to the practical implementation of the Paris Agreement NDCs and the necessity to meet those commitments, which is especially relevant for developing countries who are identifying the best pathways to achieve those objectives (Ayuk);
- Highlight not only the benefits, but the costs of resource efficiency (Germany).

The Conclusions to this discussion noted that this workstream "could consider:

- A practical research outcome focused on best practices, barriers (including costs) to achieving resource efficiency/circular economy, and how to overcome those barriers through policies across two main areas: finance (including green finance) and innovation;
- Considering linking the research to implementation of climate NDCs under the Paris Agreement;
- Work in partnership with private sector foundations in developing the research."

At the Nairobi IRP meeting (IRP24, March 2019) Paul Ekins was asked to develop Terms of Reference (ToR) for the workstream for the 25th IRP meeting (Bled, November 2019). A Workshop was held the day before the 25th IRP meeting, at which the scope and the workplan of the proposed report were considerably clarified. An incomplete ToR was presented to the Panel and Steering Committee, which expressed continuing support in principle for the report, and asked the proposed contributors to complete the ToR following the meeting and present it for adoption at the 26th IRP meeting if not before.

In response to this request a ToR was prepared for the 26th IRP meeting that sought to respond in full to the above views and issues. However, its budget was of the order of USD1.2 million, and the IRP Secretariat suggested that there was little chance of this report being funded at this level. As a result, an alternative ToR was prepared, with the title Finance for Sustainable Minerals Production, with a budget of USD508k, which focuses exclusively on financing sustainable minerals production. This new focus was suggested by the Working Group, and supported by the Secretariat and Co-Chairs, because two reports have recently explored in some detail the issue of finance for resource efficiency and the circular economy[31]. Clearly sustainable mineral production will need to contain consideration of secondary minerals production, as part of sustainability and life cycle considerations. Related sustainability work, including the circular economy, will also feed into the IRP report. But its main focus will be the financing of the sustainable primary production (including exploration, extraction and processing) of minerals.

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[31] UNEP FI 2020 'Demystifying Circular Economy Finance', to be launched at the UNEP Global Roundtable, October 15, 2020, https://www.unepfi.org/events/roundtables/unep-fi-global-roundtable-2020/; Ellen MacArthur Foundation 2020 '*Financing the circular economy - Capturing the opportunity'*, https://www.ellenmacarthurfoundation.org/our-work/activities/finance?utm_campaign=network_092020&utm_medium=email&utm_source=newsletter_mailchimp&utm_content=finance-paper&mc_cid=d366739556&mc_eid=58f80839da

However, this budget was considered still too expensive. The Steering Committee (SC) conclusions suggested that, in order to achieve cost savings, the study should explore the following focus areas:

- Minerals/metals[32] that are key for low-carbon and renewable technologies, resource efficiency and greater circularity
- Assessment of the environmental consequences of mineral resource extraction and use and other impacts of trade risks but not extending this to new areas of research

In addition, a revised ToR should limit the analysis on the overall international financial architecture and commodity pricing, and identify budget line items (e.g. working group meetings) that may no longer be necessary/possible.

This revised ToR responds to these suggestions.

## 2. PURPOSE

The purpose of this alternative ToR is to produce an assessment report which makes recommendations as to how the financing of minerals production could be reformed to bring about sustainable production of these commodities, and the equitable distribution of the resulting financial and other economic and social benefits. It is intended that this will build on the broader insights and analysis of the IRP Mineral Resource Governance report. The focus of the report will be limited to a limited number of minerals and metals that are important for renewable energy, resource efficiency and greater circularity. It will take account of the findings in previous IRP reports. These minerals and metals will be chosen in a first phase of the project, in consultation with the SC (initial suggestions have been lithium[33], cobalt, nickel, copper, manganese).

## 3. RELATION WITH THE IRP OBJECTIVE AND STRATEGY OF THE CORRESPONDING CYCLE

In the IRP Work Programme 2018-2021 Resources and Finance was identified as a major workstream in HIPA 3: Socio-economic implications of the transition to more resource-efficient economies and societies.

## 4. RATIONALE FOR THIS REPORT

The United Nations' '**Transforming our world: the 2030 Agenda for Sustainable Development**' affirms the determination to protect the planet from environmental degradation, promoting sustainable consumption and production, as well as sustainably managing its natural resources and taking urgent action to reverse climate change, thereby supporting the needs of the present and future generations.

The 2030 Agenda for Sustainable Development affirms the determination to mobilize the means required to implement this Agenda through a revitalized Global Partnership for Sustainable Development (SDG 17), based on a spirit of strengthened global solidarity, and focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries, including stakeholders and all people.

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[32] Choice be decided in consultation with the Steering Committee once the work has commenced

[33] Finland has offered to forward you some links describing the emerging battery industry in Finland – based on domestic minerals as well recycled ones: https://www.batcircle.fi/; https://www.businessfinland.fi/en/for-finnish-customers/services/programs/batteries-from-finland.

Over the course of the last few years, driven by the UN Sustainable Development Goals of Agenda 2030, the Paris Climate Agreement and the Financing for Development Addis Ababa Action Agenda, the financial system has seen important progress to direct more financial flows towards more resource-efficient, low-carbon economic activity.

As was clearly shown in the IRP Mineral Resource Governance report, the production of minerals is potentially a major contributor to sustainable development in many countries. However, at present that contribution is much reduced by excessive environmental and social impacts during production, inadequate economic linkages between the extractive sector and the rest of the economy of the country in which the extraction is taking place, and a distribution of the financial and other economic and social benefits from extraction that is not perceived as fair.

This report will:

(1) Explore the role of the finance sector in incentivizing the mining sector to produce sustainable mineral commodities, along the lines of the principles articulated in the Mineral Resource Governance report.

(2) Make a broad assessment (for the selected minerals) of the effect on minerals demand, and the environmental consequences, of moves to higher use of secondary materials in importing countries. While the principal focus of the report will be on the sustainable supply of mineral commodities, clearly this cannot be wholly divorced from considerations of the demand for these commodities, and this will be dependent on the efficiency with which these resources are used. Many countries now have aspirations to move towards sustainable, resource-efficient, green, or more circular economies. The extent that they achieve this will influence the impact that more sustainable mineral production has on importing economies, especially if it turns out that sustainably produced minerals are more expensive than their unsustainably produced counterparts.

## 5. SCOPE

This report will assess how the world's financial system (regulations, institutions, markets and businesses) operates in respect of the exploration[34] and production of the selected minerals, and how the benefits of such production are shared. Recommendations will be made for encouraging sustainable mineral production, incorporating the full environmental and social cost of production, and allowing countries to develop sustainably. Because the quantity of primary minerals required will depend to some extent on the resource efficiency of minerals use and the production of secondary minerals, through re-use, remanufacturing and recycling, the financing of these aspects of the mineral life cycle for the selected minerals, as part of wider moves towards more resource-efficient and circular economies, will also be explored.

Some of the issues which will be covered in this work are as follows (in no particular order):

[34] Exploration has been included in the scope at the request of an IRP Working Group member because: mineral exploration improves the potential for sustainability of mineral extraction by increasing choice; availability of exploration data is a major influence on long term mineral pricing; exploration is often a high-risk, high-reward game – since it depends to a substantial extent on venture capital, the financing issues are different compared to mining; availability of regional-level geoscientific survey data reduces exploration risk, but public funding for surveys is not easily available in developing countries.

- How the financial system currently facilitates mineral resource exploration and production, and the social (including in relation to human rights and gender), economic and environmental consequences.
- The implications for natural resources and the environment of the current financial system's predominantly short-term focus, and speculation in and financialisation of minerals.
- Information and disclosure in the financial system and in respect of the businesses which it finances, including considerations for due diligence for funding access, in particular for state agencies acting as investors, and how to combat lack of transparency, money laundering and corruption in financial transactions, especially as to how this relates to mineral commodity production.
- The desirable balance between public and private investment, risk and ownership in the shift towards an economy that produces minerals sustainably.
- The governance and regulation of the financial system, including central banks, especially as to how they could encourage more sustainable production of minerals.
- The operation of commodity markets, including the distribution of the financial benefits from the extraction and processing of minerals, and what new, or modifications to existing, international governance mechanisms (e.g. multilateral agreements or entities such as a potential International Minerals and Metals Agency) might be desirable to improve this operation.
- The extent and causes of externalisation of environmental costs in the extraction and processing and end-of-life management of minerals, leading to incorrect price signals in natural resource markets.
- The investment required, as one element of what is necessary to achieve sustainable mineral production, including moves towards resource-efficient, green, or more circular economies, and how this would relate to the achievement of the Sustainable Development Goals (SDGs) more generally.
- The role of institutional investors[35], impact investing, sustainability indexes and reporting as well as of information and consumer pressure and awareness, in achieving sustainable mineral production.
- The current operation and lending criteria of export credit agencies, especially as they relate to mineral production.
- Development finance, including climate finance, and the operation of the multilateral development banks, in the context of the Addis Ababa Agreement on Financing Sustainable Development, as this relates to mineral production.

Specifically in the context of key mineral-producing regions in the Global South (Africa, Latin America, Asia), key questions to be addressed include:

a) What is the distribution of costs and benefits in mineral resource extraction today?
b) How to increase the sustainable mineral exploration expenditure and mining investment in developing countries?
c) How to address the structural factors constraining the development of sustainable mining in developing countries?
d) What would be the fair price for selected commodities if the full costs of extraction, including environmental and social costs, are considered?

[35] Please see the link to the website of Dutch investors in sustainability (VBDO), which recently have produced a number of relevant reports in English on the matter. https://www.vbdo.nl/publicaties/ (relevant docs to be found scrolling down)

e) What is the extent of transfer pricing within the minerals sector and how does this contribute to illicit financial flows?
f) What financial reforms, policy instruments and strategies should be formulated to stem illicit financial flows in the extractive sector?
g) What role can sovereign wealth funds, natural resources funds and stabilization funds play in the management of mineral revenue?

## 6. STRUCTURE

The IRP member contributors to this report will be Paul Ekins (PE, coordinator), Vijay Kumar (VK), Helga Weisz (HW), Eeva Primmer (EP), Michael Obersteiner (MO), Antonio Pedro (AP), Elias Ayuk (EA), Saleem Ali (SA), Riyanti Djalante (RD), Joanna Kulczycka (JK) and Anders Wijkman (AW). Other members may of course make contributions, but these people will comprise the initial Working Group and 'Report Coordination Team'. A small provision has been allowed in the budget to engage researchers from Latin America and China, to ensure that these regions are represented in the report.

The report will be structured in the following way to incorporate the issues set out above,

**Overall title: Financing the Extractive Industry to Contribute to the Achievement of the Sustainable Development Goals**

Ch.1: Mineral commodity production, with a focus on the selected minerals, and its current environmental, social and economic consequences

- Global network representations of aggregated mineral trade in weight and value units in time series. Secondary resources will be considered in this work to the extent feasible. (HW)
- Analysis in terms of development (since about 1995), of scale, topology, asymmetries, unit prices, bottlenecks, vulnerabilities and concentrations, trade balances in global networks of mineral commodity trade networks, combined with national production and consumption data and with different risk indices to create country and commodity specific vulnerability scores, and other elements of a sustainability assessment of global minerals trade (HW)
- **The role of international trade and trade policies, including protectionist policies where governmental price setting is used to suppress market entry of new ventures or to pressure existing competitors to early M&A exits leading to unfair market dominance or even global monopolies. (PE, HW, MO)**
- Estimating commodity price volatility and the resulting economic, environmental and social implications (MO)
- Environmental impacts, including on biodiversity and ecosystems more generally, of current minerals production (PE, HW, EP)
- The distribution of financial, social and environmental costs and benefits from mineral production today (EA, AP)

(Contributors: PE, HW, MO, EA, AP, EP)

Ch.2: The financial sector and mineral commodity production today

- How the financial system currently facilitates mineral resource production, and considers the social, economic and environmental consequences, including for biodiversity and ecosystems more generally.

- The implications for natural resources and the environment of the current financial system's predominantly short-term focus, and speculation in and financialisation of minerals
- The desirable balance between public and private investment, risk and ownership in the shift towards an economy that produces minerals sustainably
- The developing country context with respect to minerals production, political economy and the situation with regard to existing financial markets.
- The governance of financial flows connected to minerals production, including illicit flows and corruption
- Development finance, including climate finance, and the operation of the multilateral and regional development banks, in the context of the Addis Ababa Agreement on Financing Sustainable Development, as this relates to mineral production.

(Contributors: PE, VK, EA, AP, EP, JK)

Ch.3: Principles, initiatives and instruments for sustainable minerals production:

- UN Principles for Responsible Investing and UNEP Financial Initiative, the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas and the Minamata Convention on Mercury Artisanal and small-scale gold mining National Action Plans
- Task Forces, Green Bonds, Climate Bonds, Sustainability Bonds
- The role of institutional investors, impact investing, sustainability indexes and reporting as well as of information and consumer pressure and awareness, in achieving sustainable mineral production
- Recent developments in respect of financial instruments in developing countries, including bonds, loans and credits from Development Finance Institutions and the World Bank Group and Regional Development Banks such as the Asian Development Bank, African Development Bank, the Development Bank of Latin America Inter-American Development Bank[36], the Bond Market and export credit agencies.

(Contributors: PE, VK, SA)

Ch.4: Investing for sustainable minerals production: What is the scale of current investments in minerals production? what is the need for investment in this sector to produce minerals sustainably over the timescale of the full mining life-cycle?

- The investment required to achieve sustainable mineral production and how this would relate to the achievement of the Sustainable Development Goals (SDGs) more generally
- Promoting resource efficiency and financing, in a life-cycle basis (including extraction of the ore, refinement of the ore to metal (or other), manufacturing of the product, assembly and customer purchase, use/re-use, obsolescence/end-of-life, and recycling or disposal) for the selected minerals as part of moves towards a more circular economy (PE)
- Financial needs for sustainable minerals production in key mineral-producing regions (Africa, Latin America, Asia (including China) and selected developed countries) (EA)
- The availability and investment implications of introducing more sustainable minerals production

(Contributors: PE, VK, MO, EA, AP, JK)

Ch.5: Financial reforms to achieve sustainable minerals production

[36] Note from Switzerland: IDB is just about to publish its IDB Extractive Industries Sector Framework Document

- Different mechanisms for governing financing: control, steering, incentivising (and structural support & motivation), with offsetting as a specific example (PE, EP)
- Financial instruments for sustainable minerals production, including development of extraction standards and certificates as enabling measures to facilitate additional financing (PE)
- The developed/downstream country context with respect to mineral supply chain due diligence and transparency (PE)
- Incentivising sustainable outcomes for commodity trading (e.g. investment decisions of **Export Credit Agencies, Sustainable Commodity Agreements) through appropriate market structures and governance (PE)**

(Contributors: PE, VK, MO, EA, AP, EP)

Ch.6: Conclusions and recommendations
(Contributors: PE, VK, HW, MO, EP, EA, AP)

## 7. BUDGET

| Cost Estimate IRP Assessment Report on Finance for Sustainable Minerals Production | | |
|---|---|---|
| **Responsible party** | **Activity** | **Budget (USD)** |
| **"Institute"** *(TBD, depending on what type of contract arrangement we agree upon)* | Support to Paul Ekins *(0.5 FTE post-doc for 2 years, 10% Nadia Ameli)* | 157,000 |
| | Support to Michael Obersteiner *(econometric assessments of selected mineral markets in terms of trend and volatility drivers)* | 30,000 |
| | Support to Helga Weisz/PIK *(material flow and commodity trade data, vulnerability analysis: 50% post-doc for 1 year)* | 50,000 |
| | Support for Eeva Primmer *(mineral extraction and biodiversity conservation, hiring a PhD level expert, 4-5 PM)* | 30,000 |

| | | |
|---|---|---|
| | Support for African partners (Ayuk, Pedro), *(sustainable commodity production)* | 30,000 |
| | Support for content on 'key mineral producing regions' (Asia, Latin America) (*contributors tbc*) | 16,000 |
| **IRP** | Working group meeting and travel<br>*(to be adjusted depending on what is needed)* | 20,000 |
| | Publishing, editing and translation of report (UNESCO) | 30,000 |
| | Development of outreach documents (i.e., policy relevant summary) | 20,000 |
| **Total Budget Estimate** | | **383,000** |

**<u>Budget Breakdown per activity</u>**

**1) Paul Ekins (from UCL costing software)**

| Category | Description | Cost to Funder | Price to Funder | Start Date | End Date |
|---|---|---|---|---|---|
| Staff (DI) | Ameli Nadia Dr | $33,106.90 | $33,106.90 | 01/01/2021 | 31/12/2022 |
| Staff (DI) | Unnamed Research Fellow | $71,903.88 | $71,903.88 | 01/01/2021 | 31/12/2022 |
| Staff (DA) | Ekins Paul Professor | $27,750.28 | $0.00 | 01/01/2021 | 31/12/2022 |
| Estate Costs | Estate Costs | $34,614.90 | $0.00 | 01/01/2021 | 31/12/2022 |
| Infrastructure Technician Costs | Infrastructure Technician Costs | $2,945.69 | $0.00 | 01/01/2021 | 31/12/2022 |

| | | | | | |
|---|---|---|---|---|---|
| Indirect Costs | Indirect Costs | $112,047.09 | $51,989.22 | 01/01/2021 | 31/12/2022 |
| | Total | **$282,368.75** | **$157,000.00** | | |

**Methods:**
Desk-based research combining standard and innovative approaches. A first scan of the available peer and non-peer literature will employ bibliometric databases (Scopus and Web of Science) to see what the literature broadly studies when it comes to sustainable mineral resources and finance. By using a set of combined queries, a database of the relevant documents will be compiled, using natural language processing, machine learning algorithms and topic modelling to classify such documents in macro topics. Such techniques can be useful tools to handle the complex interplay of global minerals production, finance and sustainability to identify key topics including predominant discourses and public discussions, concerns, and interests of various actors; the level of importance that these actors assign to certain issues; and how the related discussions have evolved over the years. Examples of this procedure applied in sustainability-driven domains can be seen at:
https://www.nature.com/articles/s41558-019-0684-5?proof=t
and https://iopscience.iop.org/article/10.1088/1748-9326/ab304d

**2) Michael Obersteiner costing (in USD):**

| | Person month (PM) | PM rate | Total |
|---|---|---|---|
| Econometrician | 4 | 7500 | 30000 |
| Grand Total | 4 | | 30000 |

**3) Elias Ayuk/Antonio Pedro costing**
Research fellow part time for 12 months (0.5FTE for 24 months) at 2,500USD/month. That brings to the total of 30,000USD

**4) Helga Weisz costing (in USD)**

| | | | | |
|---|---|---|---|---|
| Network Analyst | 6 | 8000 | 48000 | |
| Helga Weisz | | | in house | |
| Computational support | | | | in house |
| Diverse Expenditure | | | 2000 | |
| Grand total | | | 50000 | |

Tasks:
1) Harmonize bilateral trade data from UN Comtrade Trade data (maximum likelihood estimation)
2) Set up annual (1995 – 2017) trade network representations in weight and value units for total trade and app. 20 mineral commodities
3) Compute national risk exposure based on network topology for all app. 500 trade networks.
4) Integrate with import dependence measures (using material flow data from IRP)
5) Compute vulnerability scores
6) Synthesis: integrate findings with results from other work packages
7) Write report chapter and contribute to other report parts

**8. URGENCY**

There is no apparent set deadline by which this report must be prepared and presented, but the issue of the reform of the financial system so that it becomes better able to promote sustainability, including sustainable minerals production, is in itself a clearly and increasingly urgent one.

## 9. COMPLEXITY

The financial system, including how it facilitates mineral resource production, and the way it operates are complex. This report will only cover those aspects of the financial system that are relevant to the production of the selected minerals.

## 10. EXISTING KNOWLEDGE BASE

The knowledge base on sustainable finance has been much augmented recently, especially in respect of 'grey' literature, with UNEP's Inquiry into the Design of a Sustainable Financial System, the report from the Task Force on Climate-Related Financial Disclosures, and the European Commission's High-Level Expert Group on Sustainable Finance, among others. The report will build on this knowledge in conjunction with expert stakeholders, and apply it to minerals production, in order to make feasible and practicable recommendations in this area.

There are a number of economists and others within the IRP who could make a contribution to this report. So far interest has been expressed by Helga Weisz, Vijay Kumar, Michael Obersteiner, Eeva Primmer, Elias Ayuk, Antonio Pedro, Saleem Ali (SA), Riyanti Djalante (RD), Joanna Kulczycka (JK) and Anders Wijkman.

## 11. POLICY RELEVANT QUESTIONS

What financial system architecture and incentives are required to bring about sustainable minerals production and achieve greater resource efficiency and circularity by mid-century?

What do policy makers (taking into consideration country/regional contexts) need to do in order to put such an architecture and incentives in place?

What can the financial system itself do to put such an architecture and incentives in place?

What are the main non-financial policy levers that can help achieve an optimal finance system architecture?

What do businesses that seek to make sustainable use of resources and the environment need to do to attract the necessary investment to realise this ambition?

## 12. ADDED VALUE

The authors are not aware of a science-based report that looks at the production of minerals from the viewpoint of the financial sector, and makes recommendations for its reform in order to show how it can make such production more sustainable – environmentally, socially and economically. Such reports in this area that may have been produced by consultancies or the private sector will of course be consulted where they are publically available.

## 13. AVAILABLE EXPERTISE

IRP members who have relevant expertise and have shown interest in being involved in the production of this report are Paul Ekins, Michael Obersteiner, Eeva Primmer, Helga Weisz, Vijay Kumar, Elias Ayuk, Antonio Pedro, Saleem Ali (SA), Riyanti Djalante (RD), Joanna Kulczycka (JK) and Anders Wijkman.

It will be desirable for the Working Group on this report to be guided by an advisory panel with expertise in the financial sector and minerals production, so that its work may be properly informed by experience in this area. The first meeting of this advisory panel should be soon after the first meeting of the Working Group to consider and make recommendations for the proposed work plan for the report. Whether Working Group meetings are in-person or virtual will depend on the coronavirus situation.

## 14. SCALE OF POTENTIAL IMPACT AND BENEFICIARIES

None of the IRP members involved in this report are aware of any report that addresses global minerals production through the lenses of the financial system and sustainability. We believe, in the current situation of enhanced awareness of the need of large quantities of minerals for both infrastructure and zero-carbon energy, of increased recognition of the crucial role of the financial system in minerals production, and of the need to find ways to mitigate the risks that come along with sustainable mineral development, this report could have a substantial impact on multiple audiences, including policy makers, mining companies, the financial sector itself, clean technology manufacturers and OEMs, and recycling companies.. It is envisaged that its impact would be enhanced through the intention to recruit an expert advisory panel, which would only meet virtually, but which would hopefully also feel some ownership of the report and help to disseminate it widely.

## 15. PROPOSED LEAD AUTHORS

The coordinating lead author of the report will be Paul Ekins. Other IRP authors will be Vijay Kumar, Michael Obersteiner, Helga Weisz, Eeva Primmer, Elias Ayuk, and Antonio Pedro. Also on the Working Group will be Saleem Ali (SA), Riyanti Djalante (RD), Joanna Kulczycka (JK) and Anders Wijkman.

## 16. FINANCIAL AND TEAM REQUIREMENTS

The draft budget requested from IRP is above. The work will be coordinated by UCL, where the team will include Paul Ekins (coordinating lead author and Panel member), Dr Nadia Ameli (an ERC Fellow working on sustainable finance), and a post doc (to be recruited). Other authors are listed above, and each will be supported by their own teams.

## 17. WORK PLAN INCLUDING TIMELINE

It is envisaged that this report will take two years to prepare. A proposed timeline is as follows:

December 2020/post-TOR approval: contract signed, recruitment commences, and work where that is possible prior to recruitment
November 2021 (or at IRP 29th meeting): workshop with Steering Committee members to present results of work to date, and discuss emerging key messages
April 2022: circulation of first draft of report and SPM for comments to Panel and Steering Committee members at IRP 30th meeting. Request for SPM to be sent out for external peer review following amendments

November 2022 (IRP 31): request for full report to be sent out for external peer review
From November 2022: publication of SPM at suitable event
April 2023 (IRP 32): agreement to proceed with publication of full report

## 18. OUTREACH AND DISSEMINATION.

There will be very great interest in this report from policy makers, the financial sector and the business community. Outreach will be through IRP's Strategic Partners (e.g. World Economic Forum), Steering Group members, the Advisory Panel and all the stakeholders who were contacted in the context of the Minerals Governance Report. Hopefully the report could be launched at an important event such as the World Economic Forum. Other possibilities are a forthcoming UNEA, the UNEP Stockholm+50 conference or meetings of the World Resources Forum.