IMPLICATIONS FOR BUSINESS LEADERS

GLOBAL RESOURCES OUTLOOK 2019

NATURAL RESOURCES FOR THE FUTURE WE WANT

UN environment

International Resource Panel

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United Nations Environment Programme

International Resource Panel

Produced by the International Resource Panel

This document highlights key findings from the report Global Resources Outlook 2019: Natural Resources for the Future We Want, and should be read in conjunction with the full report.

"The circular economy offers tangible benefits, and provides a pathway to move away from purely extractive value creation practices. This report highlights opportunities that the current linear model overlooks, and offers science-based insights to tackle systemic challenges."

Ellen MacArthur,
Founder & Chair of Trustees,
Ellen MacArthur Foundation

"Through science-based analysis, targeted case studies and actionable recommendations, this report provides critical insights for business leaders in developing more sustainable resource management practices."

John W.H. Denton AO
Secretary General,
International Chamber of Commerce

"This report provides insightful resource use and impact information that is fundamental for strategic design decision-making around sustainable production and consumption. It underpins the opportunity of the circular economy for businesses to reduce costs, increase revenues and reduce risks."

María Mendiluce
Managing Director
Climate, Energy and Circular Economy,
World Business Council for Sustainable Development

"Succeeding in the 4th industrial revolution requires the sustainable and circular use of natural resources. This report provides important insights to help business fully understand natural resource related risks and opportunities, and offers a valuable blueprint for effective action."

Dominic Waughray,
Member of the Managing Board;
Head, Global Centre for Public Goods,
World Economic Forum

Key Messages

Today's companies and policy makers face multiple challenges, including managing economic development in the context of pressing environmental impacts such as climate change, biodiversity loss and pollution. The resource lens provides an effective approach to target multiple impacts systemically and cost-effectively.

Decoupling resource use and impacts from economic growth can achieve the Sustainable Development Goals while facilitating lasting business success within the planetary boundaries. International Resource Panel modelling demonstrates that decoupling can boost economic growth and human well-being through a focus on efficiency and innovation.

For businesses, embracing decoupling through strategies of resource efficiency, circularity and sustainable resource management is key to facing the emerging disruptions of the global economy. Not only is decoupling an effective strategy to save costs and build resilience to increasing resource price volatility and regulatory risks, it is also becoming a competitive imperative and the path to new growth. Decoupling offers companies the opportunity to create new customer value through resource-smart innovations, better services and building trust.

Businesses will need to take a new approach to strategic decision-making based on a deep understanding of the risks and opportunities emerging from global resource use and impact trends. The *Global Resources Outlook 2019* provides a new science base. Key insights include:

- Global resource use has more than tripled since 1970 to reach 92 billion tons in 2017. *Insights per material are available in the last section of this document.*
- Global material productivity has not improved in the last 20 years.
- High-income countries continue to outsource resource-intensive production. The average person in these countries relied on close to 10 tons of primary materials sourced from elsewhere in the world in 2017. This reliance has been increasing at 1.6 per cent per year since the year 2000.
- Resource extraction and processing cause over 90 per cent of global biodiversity loss and water stress, and more than half of global climate change impacts.

- Environmental impacts of material consumption are 3 to 6 times greater in high-income countries than in low-income countries.
- Without action, resource use would more than double from current levels to 190 billion tonnes by 2060. Related impacts would exceed the planetary boundaries and endanger human well-being.
- Concerted resource-efficiency and sustainable resource-management measures can reduce resource extraction by 25 per cent, significantly mitigate negative impacts and boost the economy by 8 per cent by 2060.

Decoupling business success from resource use requires a clear vision of de-materialized value creation and continuous action toward that vision. Reaching the vision requires immediate resource efficiency and circularity measures, as well as strategies to change market systems beyond the limits of the company.

Strategic coalition building is key to overcoming transformation risks and shaping the new decoupling economy. Engagement with policymaking processes must be a priority.

About this document

This document highlights and contextualizes the key findings of the *Global Resources Outlook 2019* (GRO) report for leaders in business and policy. It aims to provide a starting point for strategic decision-making for successful businesses in a sustainable economy.

In 2015, countries around the world agreed on the key parameters of a sustainable economy in the Sustainable Development Goals (SDGs), aiming to create a world of growing prosperity for all in a healthy environment. Global intergovernmental commitments further specify the most urgent environmental agendas, including the Paris Agreement to limit global warming to 'well under' 2°C, the Convention on Biological Diversity (CBD) and the Convention to Combat Desertification (UNCCD).

The *Global Resources Outlook 2019* presents a comprehensive assessment of the connection between the most pressing environmental challenges and the extraction and processing of global resources. The report provides insights of unprecedented depth into the dynamics of resource use and impacts to date and projects two possible future scenarios – one based on historical trends, and the other envisioning transformations towards sustainability. Both are conditional upon our actions today.

The assessment reinforces the International Resource Panel's central message that decoupling economic growth from resource use and its impacts must be the paradigm of a new economy that can achieve the SDGs and boost economic development. The scenarios show that concerted resource efficiency, climate mitigation and biodiversity protection measures can deliver on decoupling ambitions.

Businesses are not only key enablers in the transition to decoupling, but also need the decoupled economy for lasting business success.

The *Implications for Business Leaders* (IBL) supports businesses in using these latest findings about global resource use and impacts in strategic decision-making. It is based on consultation inputs from IRP Strategic Partners in the private sector and their members. The input of the contributing organizations is greatly appreciated: Confederation of Indian Industry, Circular Norway, Ecofys- a Navigant Company, Ellen MacArthur Foundation, Enel, Global Business Coalition, Umicore, United States Chamber of Commerce, World Business Council for Sustainable Development, World Economic Forum, and World Resources Institute. The development of *Implications for Business Leaders* was supported by SYSTEMIQ.

The GRO was requested by the Second Session of the United Nations Environmental Assembly (UNEA-2) and will be presented under the theme 'Innovative solutions for environmental challenges and sustainable consumption and production (SCP)' at the Fourth Session of the Assembly in March 2019. The full report was produced by the International Resource Panel (IRP), which aims to provide a consistent science base for decision makers by publishing updates to the Global Resources Outlook every four years.

For details about the International Resource Panel, please visit www.resourcepanel.org and access the report Global Resources Outlook 2019 at www.resourcepanel.org/reports/global-resources-outlook.

01 A new perspective: smart resource management for inclusive growth

01.1 The resource lens: an approach to target multiple challenges systemically and cost-effectively

Natural resources – biomass (wood, crops, including food, fuel, feedstock and plant-based materials), fossil fuels (coal, gas and oil), metals (such as iron, aluminium and cooper), non-metallic minerals (including sand, gravel and limestone), water and land – provide the foundation for the goods, services and infrastructure that make up our current socio-economic systems (IRP, 2017).

The use of these natural resources is also a key cause of the most urgent impacts on planetary and human well-being: the extraction and processing of natural resources alone cause over 90 per cent of global biodiversity loss and water stress, and more than half of global greenhouse gas emissions. Moreover, resource use causes pollution through waste and emissions, including particulate matter and toxic chemicals. Resource use is also closely related to economic stability. Global growth has become more dependent on commodity trading, while price volatility has become a determining factor for trade and manufacturers around the world (World Bank, 2018; UNEP, 2014; McKinsey Global Institute, 2011). Resource use and impacts also play an important role in many conflicts and migration (UNEP, 2009). Global resource use and its resulting impacts are growing: resource use more than tripled from 27 billion tons in 1970 to 92 billion tons in 2017. Plus, in contrast to widespread perceptions, global material productivity has not improved over the last 20 years.

Although businesses are aware of these growing challenges, many have previously tried to tackle specific impacts in isolation. We now know that this has limited effect, and will not sufficiently prepare businesses for the disruptions emerging from the diverse impacts of resource use. One of many examples is the cement production and use chain. GHG emissions have been on the radar of this sector for decades and have commonly been addressed with thermal efficiency approaches – also because these lead to immediate cost advantages. While thermal efficiency is important, it has almost reached its limits and has not been able to sufficiently tackle other impacts such as air pollution. In other cases, companies have focused on lightweight packaging to reduce emissions from transport but are now facing a growing problem of unmanaged plastic waste. Another example are biofuels that reduce GHG emissions from vehicle use but, in many cases, negatively impact biodiversity and compete for land that is increasingly needed for food production.

Focusing on one impact in isolation will not bring about lasting improvements and will probably not lead to the most cost-effective solution. More and more companies are understanding this and facing the questions: what would a truly sustainable company look like? Which parameters can lead to compatibility with all planetary boundaries and best avoid trade-offs?

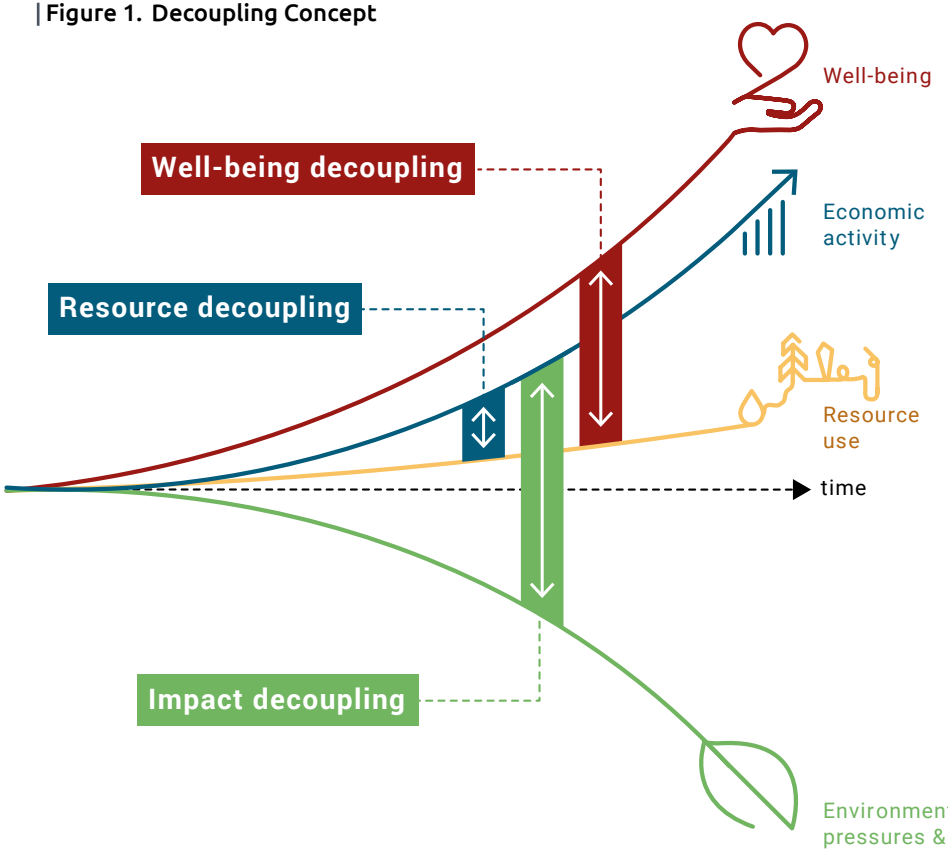
The resource lens is a powerful approach to assess integrated sustainability and target multiple challenges in an integrated manner. The strategic management of natural resources is an effective tool to reduce multiple negative impacts while saving costs, boosting innovation and increasing resilience. In the cement production case, the resource lens can lead to circular models beyond thermal efficiency, focusing on input reduction and component reuse. The use of waste materials in cement production can reduce emissions, waste and air pollution impacts. There is also great potential in component reuse, maintenance and management of resource-efficient consumption, for example through smart infrastructure build-up in cities. Circular models are most beneficial when applied across the value chain and in new business models that delink revenue from material consumption.

Companies should therefore analyse their business portfolio against all the relevant resource pressures and use the resource lens to identify how to adjust corporate strategies systematically. The comprehensive assessment of global resource flows and impacts of the Global Resources Outlook provides important scientific insights for achieving this.

Box 1.
Decoupling concept

The concept of decoupling describes the necessary conditions for an economy within the planetary boundaries. It means that resource use or a pressure on the environment or human well-being decreases or grows at a slower rate than the economic activity causing it (figure 1)

| Figure 1. Decoupling Concept



01.2 Embracing Decoupling: breaking the link between prosperity, resources and environmental costs

The impacts of current resource use exceed the planetary boundaries and, if left unchecked, will inevitably change the economy in a fundamental way. We can wait for that change to soon face risks of unknown magnitude, or we can shape the disruption now by limiting risks while creating a new economy to revive global growth under a new value paradigm.

This means shifting away from traditional strategy setting based on extrapolation of historical trends to "embracing decoupling": preparing for discontinuities and disruptions and setting out to capture the new value opportunities of the shift. It is time to take "sustainability" out of the corporate jargon and integrate implications of decoupling into regular business practices and strategy development.

Case study 1. Switching the revenue base from mass to functionality

Philips is saving costs while reducing energy and material consumption through performance-based lighting service

Royal Philips of the Netherlands is a diversified technology company. Among other measures, Philips is experimenting with new performance-based business models. An example is the 'pay-per-lux' intelligent lighting system, created in collaboration with Rau Architects, which sells hours of light instead of light bulbs. Philips retains control over the items they produce and can thus enhance profitability by saving energy and material costs in production and use, for example through smart space and natural light planning, intelligent sensors for energy efficiency and better maintenance, reconditioning and recovery (EMF, 2018d).

Key implications of embracing decoupling include improving the functionality for the customer through integrated services, while reducing material consumption across the production and consumption system. The service focus is hitting a growth trend. Services are quickly growing their share of global GDP and experiencing a sharp increase in almost all countries (OECD, 2019).

The decoupling transition goes hand in hand with the digital transformation. Digital technology will be a key enabler of circular models. It can facilitate the tracking of components for remanufacturing, decentralized electricity grids or shared mobility services (to name but a few).

At the same time, the decoupling paradigm can provide direction and purpose to a company's digital transformation, which may still evoke fear or scepticism for some (IE, 2017). Smart resource management and circular production models offer great potential value and can provide a powerful purpose for successful digital transformations.

Case study 2. Designing digital solutions to go circular

Cisco is thriving on smart resource solutions for the private and public sector

Cisco is an American multinational corporation that designs, manufactures and sells networking equipment. Cisco's engineering strategy around the Internet of Everything is focused on enabling the transition to a circular economy, with new connected devices facilitating the tracking of products, components and materials for re-use and recovery; new business models through greater connection with customers; and more effective reverse logistics chains (EMF, 2018a). In a partnership with the city of Copenhagen, for instance, Cisco helps develop intelligent solutions in waste management, parking, air quality and lighting. For example, when smart sensors indicated that only 30 per cent of waste pickups involved full bins, Copenhagen was able to optimize waste collection with better schedules and routes. This helps the city cut fuel costs and carbon emissions (Cisco Blogs, 2018).

Sustainable resource management will also demonstrate care for social and consumer concerns while enhancing trust. Most people are deeply worried about impacts such as climate change and growing plastic pollution of land and oceans (PEW, 2017). Integrated resource management is the most effective way to tackle these multiple impacts, and can help turn around trends of declining public trust in businesses (Edelman, 2018). It can also help address the next generation of investors that is increasingly focused on impact criteria (MS, 2017).

Case study 3. Creating new value through smart resource management

Natura is creating unique product value while protecting the rainforest and strengthening local communities

Natura is a Brazilian cosmetics company with an annual turnover of more than USD 2 billion. Having built the company and its reputation around sustainability from the beginning, in 2011 it developed an inclusive business model that leverages traditional community knowledge to actively promote biodiversity assets whilst preserving the natural capital of the Amazon rainforest. As a result, Natura has a new revenue-generating product line; long-term sustainable employment has been generated for more than 2,000 families and the risk of extinction of the ucuuba tree through timber felling has been decreased. Natura plans to sustainably source 30 per cent of all its raw materials from the Amazon rainforest by 2020, while generating R$1 billion of revenue in the region (EMF, 2018b).

01.3 Resource management as a new competitive imperative: saving costs, reducing risks and realizing new growth

Concrete benefits of sustainable resource management for businesses include cost savings, risk mitigation and new growth opportunities.

Smart use of natural resources will increasingly translate into cost reductions and improved margins. The IRP study *Re-defining Value: The Manufacturing Revolution* shows that manufacturers of industrial printers, vehicle parts and heavy-duty and off-road equipment in the United States save 18 to 44 per cent in costs per unit through remanufacturing and comprehensive refurbishment strategies (compared with the same product made from new materials). The same measures reduce production waste and GHG emissions by up to 90 per cent (IRP, 2018a).

There is great potential for improved margins through smarter resource management in many sectors.

Case study 4. Smart nutrient management for cost savings and better products

Ostara is providing better fertilizing solutions and boosting efficiency in wastewater treatment through nutrient recovery

Ostara is a provider of nutrient management solutions, known for its eco-fertilizer. The company recovers otherwise pollutant nutrients, phosphorus and nitrogen from municipal and industrial water streams, and transforms them into a continuous-release eco-friendly fertilizer. The process helps wastewater treatment plants reduce nutrient management costs, meet increasingly stringent discharge limits and improve operating reliability, while reducing the risk of nutrient leaching and runoff. According to a recent partner, a water treatment specialist in the United Kingdom, the annual savings for water could be in the hundreds of thousands of Pounds (Ostara, 2018; EMF, 2018c).

Sustainable management of natural resources can mitigate risks. Current means of resource use are liable to impact regulations, within and across borders. For example, the People's Republic of China not only temporarily shut down about 40 per cent of its factories due to pollution concerns in 2017, but also stopped accepting shiploads of other countries' plastic and paper waste - thereby affecting national and international industry (Bloomberg, 2018; Forbes, 2017). Another example is the French ban on all non-biodegradable plastic plates and cutlery, which comes into force in 2020. Proactively monitoring and improving the input, processing, (re)use and waste management of materials along their value chain is critical in anticipating the implications of environmental regulations. Reducing dependency on virgin natural resources through resource efficiency measures can also increase companies' resilience in the face of increasing global resource price volatility.

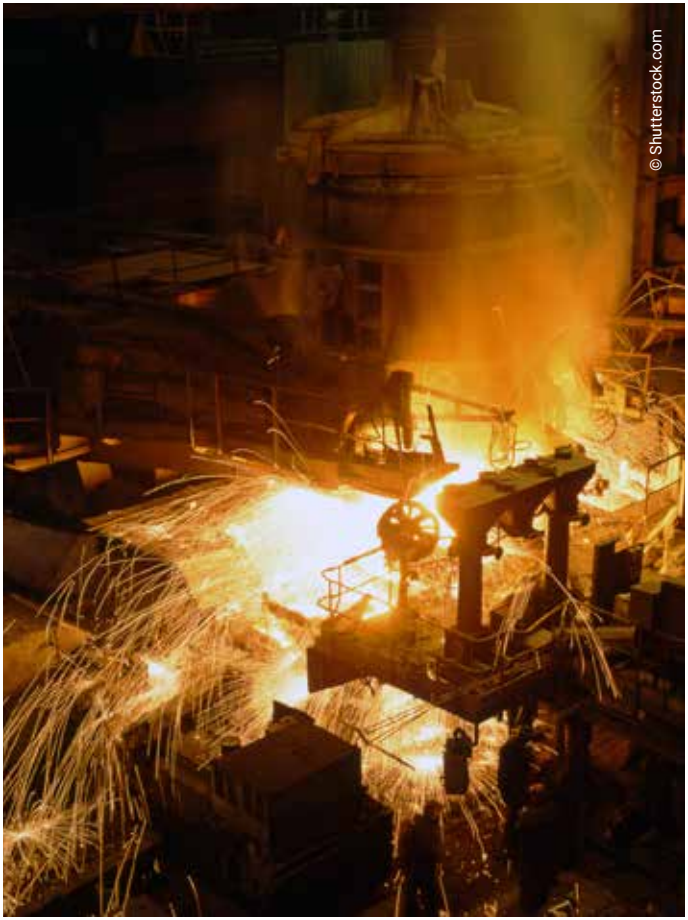
Case study 5. Driving independence from virgin materials for producers and consumers

Umicore is boosting revenues and reducing virgin material consumption through a circular model in hi-tech material provision

Umicore is a global materials technology and recycling group. It started with a focus on mining and refining and transitioned to a specialist materials company in the 1990s. In the 2000s, Umicore added the automotive catalyst sector to its portfolio and scaled its recycling services. Umicore today transforms metals into hi-tech materials and secures a significant share of its supply by recycling scrap and end-of-life products in close collaboration with its customers. Umicore presently has the world's largest facility for recycling precious metals from complex residues. In 2017, 64.6 per cent of its overall revenues came from clean mobility and recycling (Umicore, 2017; 2018).

Including sustainable resource management into business strategies can generate new growth and productivity, by developing resource efficient innovations with new customer benefits to revive slowly growing market segments, such as car travel, food production, retail or utility provision. In

emerging economies, fast-growing urbanization provides huge opportunities in terms of innovation and growth for resource efficient businesses, for example in the area of shared mobility, waste heat reutilization for district energy or strategic materials exchange (IRP, 2018b).



Case study 6. New revenues by targeting systems circularity and new technology

Enel is creating long-term shared value thanks to a circular approach in providing electricity services, by deploying renewables on a global scale and digitalizing the grid to enable customers to take center stage of a circular revolution

Enel is one of the leading actors in the global energy transition, being the world's largest private player in renewables by installed capacity (43 GW) and the first private network operator by end users (73 million) (Enel 2018c). In line with the Open Power vision – launched by Enel's CEO Francesco Starace - Enel has been transitioning towards a circular business model, centred on innovative technologies, digitalisation, smart grid development, renewable energies and human capital. For instance, Enel X is developing new technologies to implement a circular vision for the cities of tomorrow and is carrying out a National Plan to install a charging infrastructure for electric vehicles in Italy to increase access and competitiveness of electric mobility as a circular means of transport. Furthermore, thanks to Enel's Open Innovation approach, the Group is developing cutting-edge technologies such as the Vehicle to Grid (V2G) through which electric cars, when parked, can be used as "batteries on wheels" contributing to balancing the grid (Enel 2018a). One of Enel's flagship circular projects is the Futur-e project that entails the circular upcycling of 23 thermal power plants through the engagement with stakeholders and local communities. Thanks to Futur-e, dismissed sites will be shifted towards new destinations outside energy production, creating shared value by catching up new business opportunities and providing jobs for the territory. The strategic and systemic approach in underpins a sustainable and shared long-term value creation as well as continuous performance improvement. Thanks to this, looking at the past three years, Enel has increased its net ordinary income from EUR 2.9 billion in 2015 to 3.7 billion in 2017 (Enel 2015; 2017 results presentation).

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02

A better science base is now available: key insights into global resource flows and their impacts

Businesses will need to take a new approach to strategic decision-making based on a deep understanding of the direct risks and opportunities emerging from global resource use and impact trends presented in the Global Resources Outlook.

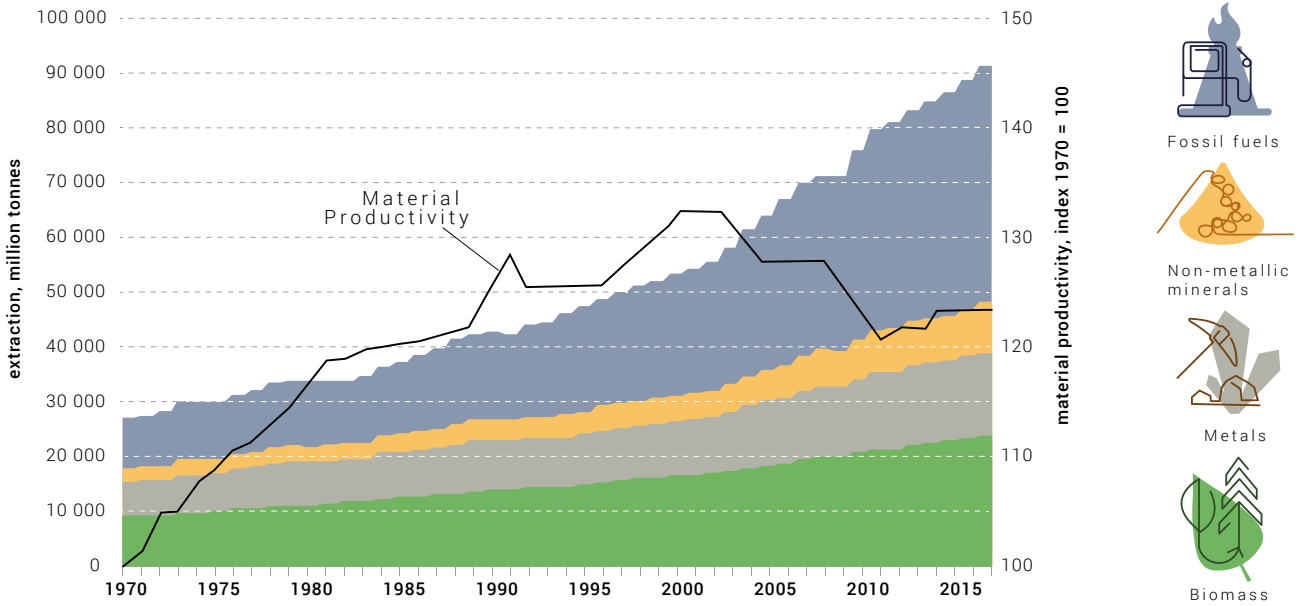
The report's comprehensive assessment of global resource flows and impacts provides insights for companies throughout the value chain.

02.1 The GRO provides deeper understanding of global resource flows and implications: extraction, consumption and trade

Global resource use has more than tripled since 1970, and global material productivity has not improved in the last 20 years. During the period 1970 to 2017, annual global extraction of materials more than tripled at an annual average growth of 2.6 per cent. The global average material demand per capita grew from 7.4 tons in 1970 to 12.2 tons per capita in 2017.

Improvements in material productivity have increased much more slowly than labour and energy productivity. Material productivity started to decline around the year 2000 and has stagnated in recent years. Material productivity has improved rapidly in many developed countries, but globally this has been outweighed by the simultaneous shift in global production away from more production efficient economies to economies that have a lower material productivity.

| Figure 2. Global material extraction, four main material categories, 1970 - 2017, million tons



Find details in material developments in the last section "Key insights per material".

High-income countries[1] consume 27 tons of materials per capita, low-income countries only 2 tons per capita annually[2].

When assessing the global distribution of resource use and its implications, different indicators offer different insights.

One direct indicator of resource use is extraction. It shows that 10 economies are responsible for over 68 per cent of global material extraction. China extracted more than one third of all materials in 2017, followed by India with 7.6 per cent and the United States with 7.1 per cent. As an income group, upper-middle income countries are the biggest material extractors in total. Find details on the distribution of extraction in chapter 2 of the full report.

The extraction of materials, however, represents only one side of resource use. On the other side stands resource consumption. Within consumption, there are two measurement approaches offering different understandings of the global dynamics.

Domestic material consumption (DMC) measures the physical quantity in tonnes of materials extracted from or imported into a nation's territory. While this is an important indicator of consumption to assess local impacts of extraction and processing, the DMC indicator cannot fully reflect the final consumption drivers of global resource production and related impacts.

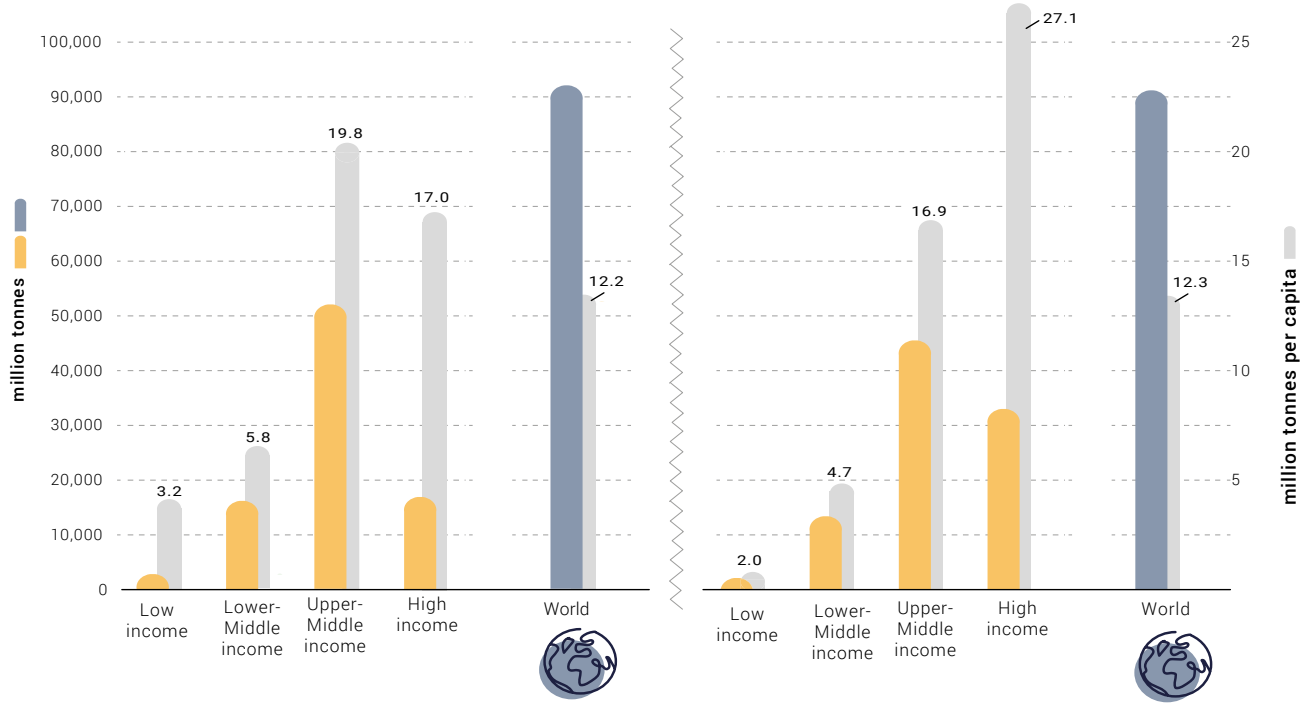
1 Please find details on the country grouping per income level in the Global Resources Outlook 2019: Methods Annex at www.resourcepanel.org/reports/global-resources-outlook.
2 Measured in material footprints.

Many countries, specifically in the high-income group, import large amounts of end products that were mostly manufactured in middle-income countries (such as electronic devices). Using the DMC, only the physical weight of the imported final devise would go on the consumption 'account' of the importing country. However, the additional amounts of materials used in the production process would remain in the account of the manufacturing or extracting countries. The total amount of mobilized resources for the production chain can be substantially larger than the weight of the end product, as waste is created during manufacturing, primary processing or the extraction of the materials.

The indicator *Material Footprints (MF)* therefore provides a significantly increased understanding of consumption as it attributes all resources mobilized globally to the consumer of the final product in virtual tonnes of imports.

Measured in DMC, upper-middle income countries are the largest per-capita material consumers. However, while upper-middle income countries are consuming large amounts of materials to build up infrastructure, they also increasingly export products to high-income countries.

Figure 3. Material consumption trends per country income groups in Material Footprints and Domestic Material Consumption in total and per capita



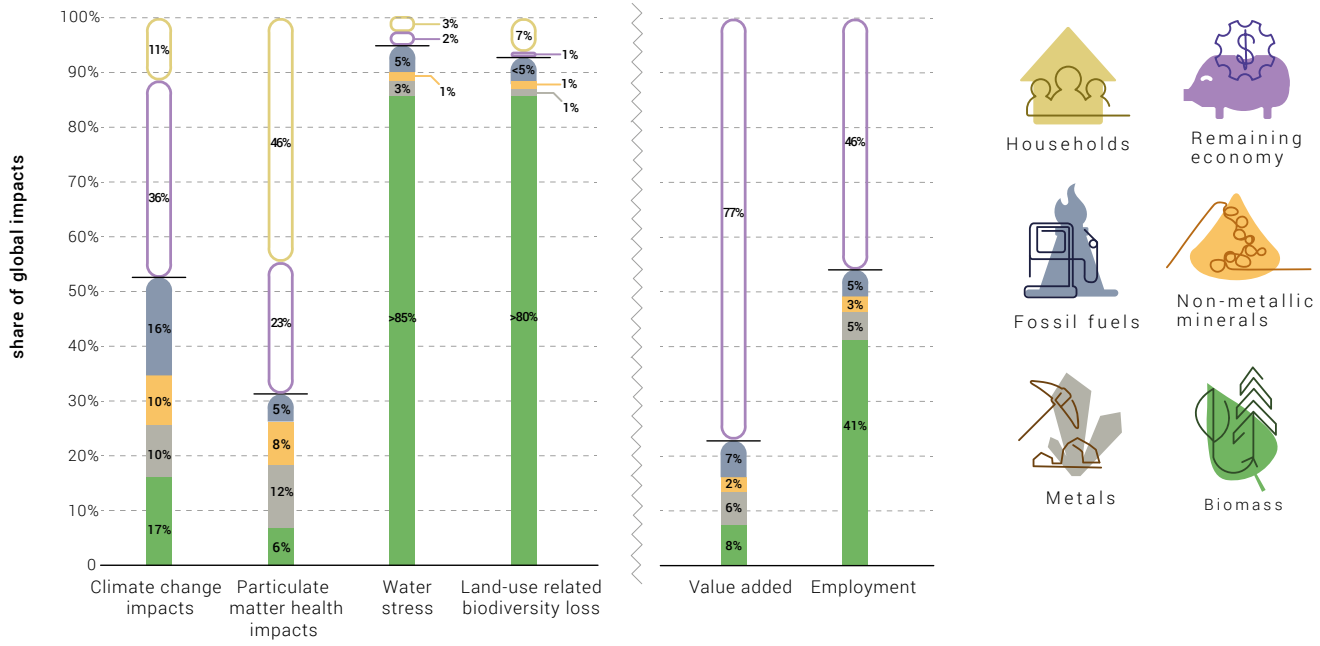
In terms of final consumption (in Material Footprints), high-income countries are by far the largest consumers per capita, consuming 27 tons of materials on average, which is 60 per cent higher than the upper-middle income countries and more than ten times the level of the low-income group at two tons per capita. Figure 3 shows the different emphases of the DMC and MF consumption indicators.

High-income countries are increasing their resource import dependence by 1.6 per cent per year.

The different trade indicators follow the same logic, and offer complementary insights into the dynamics of global resource trade and trade dependencies. The Raw Material Trade Balance (RTB) indicator considers the material mobilized by the production chain of a product and attributes it to the importing country in virtual tonnes. This complements the direct indicator (Physical Trade Balance (PTB)) that only considers physical tonnes of materials crossing borders.

The GRO shows that, in RTBs, the economic activity in high-income countries depends on high and increasing levels of primary material extraction in other countries. The average person in the high-income group in 2017 was reliant on the mobilization of 9.8 tons of primary materials elsewhere in the world, with reliance increasing at a rate of 1.6 per cent per year since the year 2000.[3]

| Figure 4. Global impacts of extraction and processing by resource type, remaining economy and households



3 The analysis is based on the IRP Material Flows database, the most comprehensive of its kind, available at www.resourcepanel.org/global-material-flows-database.

Resource importing economies and businesses should carefully assess their growing trade dependencies and risks in the light of the distribution of value added along the production chain, increasingly volatile prices and the urgent limits set by the impact of resource use. The risks of heavy reliance on resource exports, must also be carefully assessed in less diversified economies. Developing context-smart decoupling plans must be a strategic priority for any decision makers aiming to increase prosperity on the macro- and microeconomic levels.

02.2 The GRO clarifies the impacts of resource use and their distribution

Environmental impacts of resource use have grown more slowly than the economy overall since 1970, but their absolute growth trend is still increasing and exceeding the planetary boundaries. Resource extraction and the processing of resources into materials, fuels and food cause over 90 per cent of biodiversity loss and water stress, and more than half of global climate change impacts.

Figure 4 shows the impact shares of the different material groups, and the final section of this document[4], Key insights per material, provides more specific details for each type of material.

The Global Resources Outlook 2019 focuses predominantly on the impacts of materials related to their extraction and primary processing, and presents details of the impacts of their use in the economy and households in certain cases.

Environmental impacts of material consumption are three to six times greater in high-income countries than in low-income countries. In accordance with the material footprints (see previous section), high-income countries outsource large shares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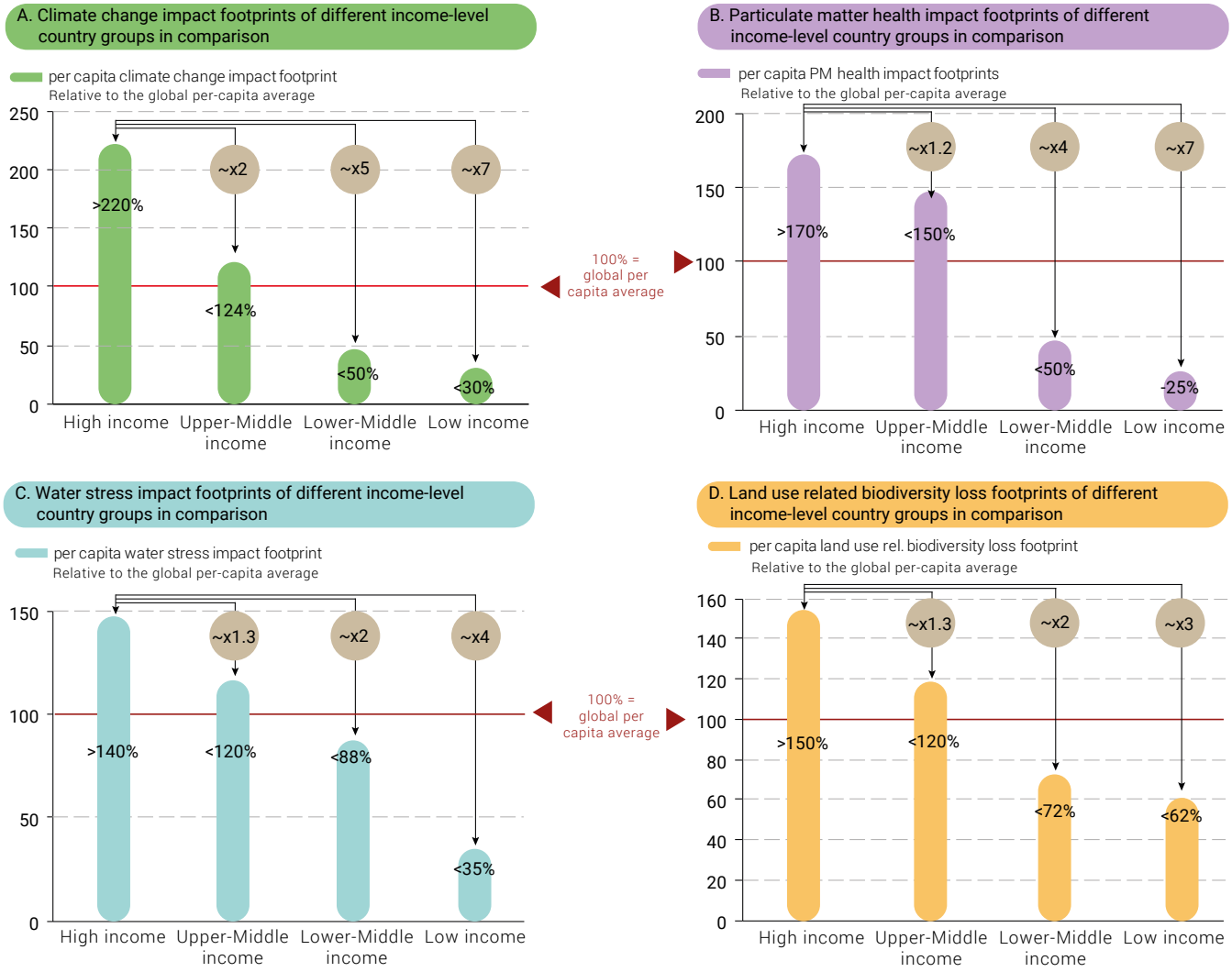
4 Remaining economy refers to economic activity excluding resource extraction and processing

of the production related impacts to middle- and low-income regions through trade.

Figure 5 shows the different per capita impacts of material consumption per country group.

| Figure 5. Per capita impacts of consumption, by income-level country group



02.3 The GRO puts forward decoupling as a viable avenue for continued and inclusive growth

The Global Resources Outlook presents two very different scenarios for 2060.

Historical Trends Scenario: business as usual will damage human well-being and increase risks for businesses

The first scenario *Historical Trends* shows that continuing 'business as usual' is not an option for societal well-being or business success.

If we proceed with consumption and production as usual, global material use would more that double from 2015 levels to reach 190 billion tonnes by 2060. Resource use per capita would grow from 11.9 tonnes to 18.5 tonnes. This growth would result in substantial stress on resource supply systems and in higher levels of environmental pressures exceeding the safe operating spaces for society and companies.

Towards Sustainability Scenario: radical resource management and efficiency initiatives can mitigate environmental dangers, improve well-being and boost economic growth by 8 per cent globally

The second scenario shows that there are effective and feasible resource efficiency and sustainable consumption and production (SCP) measures to pursue a future that supports human well-being and lasting business success. The measures modelled are:

- **Reducing materials use** (iron and steel, non-ferrous metals, chemicals and plastics and forestry products) in manufacturing and construction through a consistent mix of measures (including regulations, technical standards, public procurement and a shift in taxation – including for GHG emissions - from income to material use) to increase innovation, increase demand for resource efficient products and increase recycling.
- **Capturing emissions** through bio-sequestration and carbon dioxide removal technologies, including bioelectricity with carbon capture (BECCS) and direct air capture (DAC) - all supported by public investments.
- **Protecting landscapes and life on land** through biodiversity conditions on bio-sequestration solutions, reducing crop-based biofuels (by immediately phasing out subsidies) and limiting agricultural land. Driving policies include a carbon levy for the financing of carbon sinks and policies to conserve native vegetation and key biodiversity areas.
- **Changing societal behaviours,** such that consumption patterns shift 50 per cent of current meat consumption (less in regions of low-meat diets) to plant-based protein, while halving food waste by 2050 (for example, through improved public education).

The *Towards Sustainability* scenario projects the following outcome in 2060:

Net economic benefits would be visible by 2030, and increase more up to 2060. Sustainability measures boost economic growth by 8 per cent over *Historical Trends*. Average incomes grow by 6 to 18 per cent in low- and medium-income countries by 2060, and by around 4 per cent in high-income countries. Economic boosters include improved resource efficiency and reduced food waste.

Annual global extraction is 25 per cent lower than under Historical Trends, reaching 143 billion tons in 2060. Global resource productivity increases by 27 per cent from 2015 to 2060. A slowdown in natural resource use in high-income countries offsets increasing use among emerging and developing economies. Per capita resource use converges across different

country groups – decreasing to 13.6 tonnes per capita in high-income countries and growing to 8.2 tonnes per capita in low-income countries.

Well-being indicators grow faster than resource use, leading to a sizeable relative decoupling of resource use from income and essential services such as energy and food.

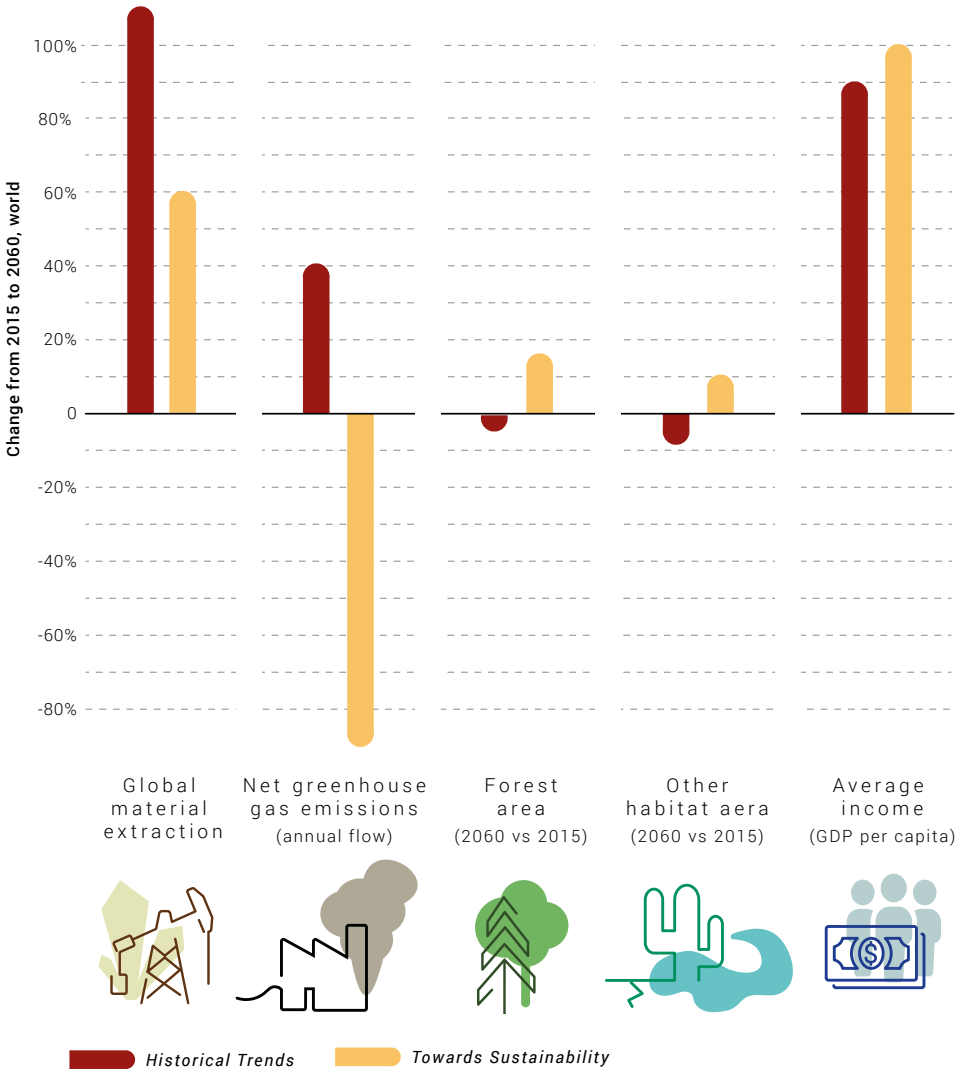
Negative environmental impacts decouple from economic growth and resource use by 2060. Resource efficiency policies alone[5] would reduce GHG emissions by 19 per cent compared to *Historical Trends*. Combined with other climate measures, global emissions can fall by 90 per cent in 2060 rather than rising by 43 per cent. Global habitat loss is reversed, thereby preventing the loss of 1.3 billion hectares of forests and other native habitat and restoring a further 450 million hectares of forests by 2060.

It is important to note that the scenario describes types of measures *towards* sustainability. The depicted changes do not reflect limits of what can be achieved by better resource management but rather the pathways of concerted action. Even greater gains are possible, for example, through circular economy measures that are not yet fully accounted for in this model. With global cooperation, circular economy models could also improve the projected smaller gains for material exporters and high-income countries. For instance, a shift to remanufacturing and recycling of materials could diversify and add high value-added economic activity to extraction focused economies. Moreover, circular economy is key in the scaling of renewable energy supply. Technologies in solar and wind energy, for example, are likely to increase the demand for metals (which are particularly suitable for reuse).

Figure 6 summarizes the projections of both scenarios.

5 The scenario considers resource efficiency best practices in manufacturing and construction and does not yet account for the full possibilities of the circular economy. Future modelling will further assess the potential of a circular economy.

Figure 6. Summary of selected changes from 2015 to 2060 in the 'Towards Sustainability' vs the 'Historical Trends' scenario



03 Making decoupling a reality: business and policy must target systemic actions

03.1 Starting the transition to decoupled business success

A successful decoupling strategy must merge the concepts of incremental and radical innovation. Although steps taken can be small at a time, they must continuously move towards fundamentally decoupling the business model and the economy. Incremental steps must be combined with more disruptive leaps where most beneficial, for example to secure first mover advantages.

Create a vision of decoupled value creation.

To guide the continuous changes, the first step is to envision the resource-decoupled alternative to today's mode of value delivery. Considerations have to go beyond the borders of the company or sector and should create a picture of a target system for decoupled value creation. The systemic approach can be illustrated by the Enel example (see case study 6) in which several organizations, together with the public sector, are creating a system that enables more value creation from renewable energy. The vision must be based on a comprehensive assessment of a company's resource flows up and down the value chain, the direct and indirect use of key materials and the related costs, risks and opportunities.

Get inspired by frontrunners and learn from examples.

As a second step, it is useful to scan the activity map for promising innovators in relevant areas and identify opportunities to learn from them. The case studies in this document illustrate that there are frontrunners out there in almost all sectors. Examples of missed innovation can also be insightful, including companies that failed to embrace recent digitalization trends or tried to manage environmental requirements, such as emissions standards, with an overly narrow innovation approach.

Move towards the vision – combining immediate actions with long-term system strategies.

In the transition to decoupled value creation, immediate improvements in resource productivity will happen in parallel with more long-term actions to progress the systemic conditions for decoupled business success.

One immediate step is to identify and quantify the company's inefficiencies and waste, and the related value at stake. A few key questions can help develop strategies to capture that value (see box 2).

Box 2. Key considerations for capturing the value of resource efficiency and circularity

- How can the business change its product design to capture most value from resource productivity across the production and consumption system? Designing products that are durable and suitable for reuse, repair or remanufacturing is relevant to many sectors. Shifting products to services, as in the Philips case study, is often particularly effective.
- How can the business change its input materials to more sustainable, regenerative or circular ones? The type, sourcing and reuse of input materials offer substantial opportunities across sectors from construction to agribusiness, specifically when considered together with industrial symbiosis possibilities.
- How can the business make best use of supporting (digital) intelligence? New data applications can increase transparency, traceability, adaptive and agile management or create new market spaces (inter alia) to make circular models increasingly profitable.
- How can internal incentives, communications and organizational structures better support the resource smart transition? Targeting communications to increase understanding of the vision among board members or shareholders is one example.
- What would be the cost of not moving forward in an economy that is exceeding the planetary boundaries? Considerations include stranded assets, brand exposure, regulatory changes and short-lived innovations.

While resource management improvements including efficiency and recycling within the company can already generate considerable benefits, especially in less materially efficient economies, there is much more untapped value in shaping decoupled market systems. For example, circular measures in manufacturing such as repair, refurbishment or remanufacturing can immediately create economic benefits through material savings. However, the benefits will multiply with systemic changes in global value chain cooperation, consumer demand, price signals, digital and physical reverse infrastructure systems and regulatory support. As systemic conditions are not yet moving fast enough, many companies perceive them as risks: the risk of lacking market demand for new products, scale-up risks through high innovation costs and initially low volumes, value chain risk of misaligned incentives and policy risks mainly through misdirected fiscal policies.

Collaboration in partnerships and coalitions is a powerful approach to overcoming these risks and turning systemic conditions into enablers of business success.

03.2 Creating coalitions for systemic change and overcoming transition risks

Working in coalitions can help to create vision, identify and learn from frontrunners, as well as to overcome transition risks and shape favourable market systems.

Coalitions work to engage policymakers and increase transparency for their members. They can promote consumer trust through standard setting and communication, while helping to align value chain players. Working in coalitions can support scaling through knowledge sharing or partnering for infrastructure development. They can also facilitate risk-sharing partnerships and access to capital. The following are some illustrative examples of coalitions working for a system that supports sustainable resource management.

The Ellen MacArthur Foundation (EMF) brings together corporates, governments and cities, academic institutions and emerging innovators to help members build capacity, network and collaborate with key organizations around the circular economy in its CE100 programme. The Foundation is also a knowledge partner of the World Economic Forum's Platform for the Acceleration of the Circular Economy (EMF, 2018).

The We Mean Business Coalition was founded in 2014 to drive global climate policy and has been active in the run-up to the Paris Agreement, as well as in its implementation since 2015. It includes other business coalitions such as the Prince of Wales's Corporate Leaders Group or the World Business Council for Sustainable Development (WMBC, 2018).

The WBCSD also offers a specific company alliance programme in the circular economy space called Factor10. It brings together companies to advance circular metrics, as well as policy, in the field. Furthermore, the WBCSD offers an umbrella for regional coalitions such as the Brazilian Business Council for Sustainable Development (CEBDS), which advocates for policies that enable sustainable business towards the national government (WBCSD, 2018; CEBDS, 2018).

The Energy Transitions Commission (ETC) is a more specialized example. ETC focuses on the transition to low-carbon energy and industry systems, including the decarbonization of 'hard to abate sectors' such as heavy industry and heavy-duty transport. It promotes demand management, including resource efficiency and circularity, as one of the most effective solution pathways. Its activities include knowledge creation, such as the recent *Mission Possible* report, policy engagement and support for the implementation of decarbonization solutions within industry (ETC 2018).

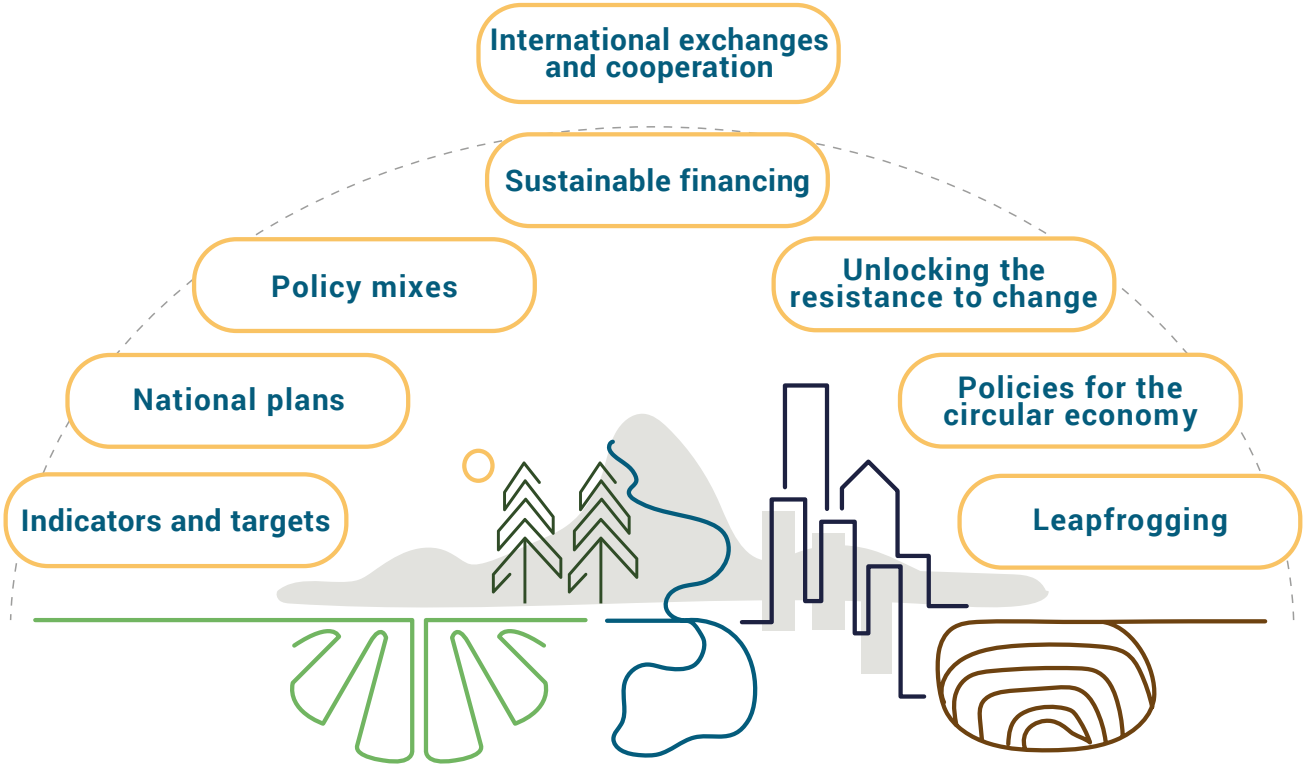
Another specialized example is the Responsible Battery Coalition, an alliance of companies, academics and NGOs to advance the responsible production, transport, sale, use, reuse, recycling and resource recovery of batteries and other energy storage devices (RBC, 2018), for example by promoting take-back schemes with major retailers.

A country-specific example is the Confederation of Indian Industry (CII), which is a non-governmental industry association. CII offers executive education, tailored information materials, fellowships and other services to industry leaders interested in the circular transition (CII, 2018). CII also engages with local and national governments, for example in the development of target setting and resource-smart industrial policy plans.

03.3 Enabling the transition through multi-beneficial policies

The right policies are key to driving the transition to a decoupled economy. Policies help with: setting the right economic incentives; concerting measures nationally and globally for effectiveness and a level playing field; and supporting society through the changes (through education and mitigation of transition losses for example). Engagement with policymakers must therefore be top of the agenda for progressive businesses and coalitions. The eight key recommendations by the IRP to policymakers summarized in figure 8 can provide guidance. Business leaders must engage with policymakers in an inclusive process to help identify strategic leverage points and support the often-challenging transitions from the status quo to sustainability.

Figure 7. Elements of multi-beneficial policymaking towards decoupling



a. **INDICATORS AND TARGETS.** National resource efficiency targets are an important first step, but international targets for sustainable levels of global resource consumption are also needed.

b. **NATIONAL PLANS.** Backed by evidence and analysis and the engagement of stakeholders, national plans can identify priorities and lay out a coordinated path to achieving national targets.

c. **POLICY MIXES.** The success of the resource efficiency strategy is contingent on a combination of policy actions – the integration of natural resources legislation with biodiversity and climate policies, for example.

d. **SUSTAINABLE FINANCING.** Governments can provide tax incentives and bonds for environmental projects, and private sources can provide financing tools that are accessible at the local level.

e. **UNLOCKING THE RESISTANCE TO CHANGE.** Targeted government support in the form of education and training programmes can help people adjust to the changing labour market. The revenue raised from any environmental taxes that support new programmes can help mitigate these and other negative distribution effects.

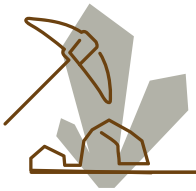
f. **POLICIES FOR THE CIRCULAR ECONOMY.** Policy considerations include establishing an effective infrastructure for waste management and recycling, incentivizing extended product life cycles and intelligent product design, and ensuring that current regulations create no barriers to the development or adoption of value-retention processes.

g. **LEAPFROGGING.** Industrializing countries can leapfrog old technologies and bypass the resource-intensive pathway of development paved by high-income, industrialized countries.

h. **INTERNATIONAL EXCHANGES AND COOPERATION.** International exchanges and cooperation can help ensure fair competition in international trade, help countries navigate common obstacles, and cooperation can help compensate for unequal burdens, responsibilities and capabilities.

In short, not only is decoupled customer value (greater benefits for customers that are de-linked from material resource use) the next growth paradigm for businesses, it is also urgently needed to manage the increasing negative impacts of resource use on human well-being and the environment. Strategy setting must shift away from the extrapolation of historical trends to the active targeting of deep market changes, using the available and growing science-base of global resource flows, impacts and implications. Frontrunners show that resource-smart practices can be profitable in the short-term, and that there is more value in redesigning business models and shaping new markets. Continuous innovation steps must be combined with a decoupling vision and collaboration strategies, particularly with policymakers, to influence systemic conditions and overcome transition risks.

GRO 2019 Key insights per material[6]



Metals

Use of metals 1970 and today (2017)
(see also figure 2)

Extracted 1970 **2.6 billion tonnes**

Extracted 2017 **9.1 billion tonnes**

Metals extraction has **increased 3.5 times** between 1970 - 2017

Impacts of extraction and primary processing today (2017) - in shares of total global impact
(see also figure 4)

- **10%** of global **climate change impacts**
- **12%** of global **particulate matter health impacts**
- **03%** of global **water stress**
- **01%** of global **land-use related biodiversity loss**

Exemplary impacts of key materials within the group (related to their extraction and processing)

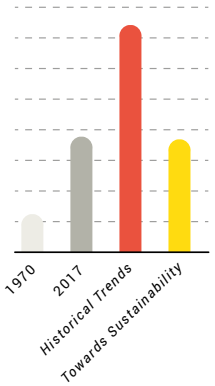
- The **iron-steel production chain** has the largest climate change impacts, with about two thirds of the overall metals group.
- **Aluminum production** has the second highest climate change impacts, with about one quarter of the group.
- In the **processing of copper and precious metals** toxicity impacts are the major concern, (representing about 30-45 per cent of toxicity impacts of the metals group)

Projected extraction in 2060 if we continue historical trends

Metals extraction in 2060 in the **'Historical Trends' scenario**:
18 billion tonnes (compared to 9.1 today)

Projected extraction in 2060 if we adopt concerted SCP measures today
(at net economic benefits)

Total extraction in 2060 in the **'Towards Sustainability' scenario**:
9 billion tonnes, 48 per cent less than in a historical trends scenario. Improvements in production and use efficiency would be combined with lower impact processing technologies.



6 Section four of this document summarizes key findings from different chapters of the report Global Resources Outlook 2019. Underlying datasets of the chapters can differ slightly after 2014. Please refer to the technical annex of the full report for more information.

Key approaches to Sustainable Consumption and Production (SCP)

Key approaches include the efficient use of metals in construction and manufacturing, circular models for components and metals recycling.

Metals can be melted and reused indefinitely, as long as alloys are not contaminated by weakening or toxic elements. Secondary production considerably reduces the environmental impacts of metal use because it avoids the extraction and processing of the ores.

However, the amounts of scrap metal available are unable to match the large global increase in demand for many metals (e.g. steel), specifically in emerging economies. Efficient use is key, for example through smart infrastructure planning, as well as low-impact processing technologies.

Beyond recycling, remanufacturing and refurbishing have proven highly effective in impact reduction and value retention where applicable.*

* A detailed analysis of circular models in manufacturing can be found in the IRP report '**Re-defining Value: The Manufacturing Revolution**'.

Non-metallic minerals

(mainly sand, gravel and clay)

Use of non-metallic minerals 1970 and today (2017)
(see also figure 2)

Extracted 1970 **9 billion tonnes**

Extracted 2017 **44 billion tonnes**

Non-metallic minerals extraction was **4.9 times higher in 2017** than in 1970, which represents the highest growth rate of all resource groups

Impacts of extraction and primary processing today (2017) - in shares of total global impact
(see also figure 4)

- **10%** of global **climate change impacts**
- **08%** of global **particulate matter health impacts**
- **01%** of global **water stress**
- **01%** of global **land-use related biodiversity loss**

Exemplary impacts of key materials within the group (related to their extraction and processing)

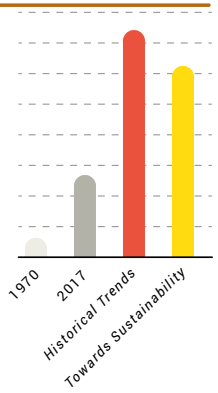
- **Cement production** has the highest climate change impacts (with over 80 per cent) and particulate matter health impacts (with over 50 per cent of the non-metallic minerals group).
- **Sand/gravel and limestone** have a minor impact on the global average. Nevertheless, mining activities may have severe local impacts on ecosystems.
- **Phosphorus fertilizer application** has high toxicity impacts that are more significant in the usage phase.

Projected extraction in 2060 if we continue historical trends

Non-metallic minerals extraction in 2060 in the **'Historical Trends' scenario**: **112 billion tonnes** (compared to 45 today)

Projected extraction in 2060 if we adopt concerted SCP measures today
(at net economic benefits)

Total extraction in 2060 in the **'Towards Sustainability' scenario**: **94 billion tonnes, 17 per cent less** than in a historical trends scenario. Improvements in production and use efficiency would be combined with lower impact processing technologies.



Key approaches to Sustainable Consumption and Production (SCP)

In the area of cement, key approaches include efficient construction design and the use of high-performance concretes or substitutions with regenerative material such as cross-laminated timber where possible. Furthermore, direct reuse of building components must be increased.

Resource-smart infrastructure build-up will be crucial, particularly in growing cities. "Strategic intensification" can reduce material demand by establishing a "well-articulated networked hierarchy of high-density nodes that are interconnected", densifying cities and providing services to citizens at short distances (IRP, 2018b).

Processing techniques must also be substantially improved globally, for example in clinker production (main ingredient of cement). There is potential in the substitution of primary fuels and raw materials for waste materials and the installation of carbon capture and storage.

In the field of phosphorus and potassium, the impacts of eutrophication and toxicity could be lowered by avoiding over-fertilization. Approaches include precision agriculture, technologies to purify phosphogypsum to enable its utilization (for example in the building sector) and technologies that recover phosphorus from sewage sludge (ash). Other measures include the recycling of organic waste by anaerobic digestion or composting. Depending on the wastewater infrastructure, urine separation could be another way recycle nutrients such as phosphorus or nitrogen for agriculture.

Fossil Fuels

Use of fossil fuels 1970 and today (2017) (see also figure 2)

Extracted 1970 **6 billion tonnes**

Extracted 2017 **15 billion tonnes**

Fossil fuel extraction was **2.5 times higher in 2017** than in 1970.

Impacts of extraction and primary processing today (2017) - in shares of total global impact (see also figure 4)

- **16%** of global **climate change impacts**
- **05%** of global **particulate matter health impacts**
- **05%** of global **water stress**
- Less than **05%** of global **land-use related biodiversity loss**

Exemplary impacts of key materials within the group (related to their extraction and processing)

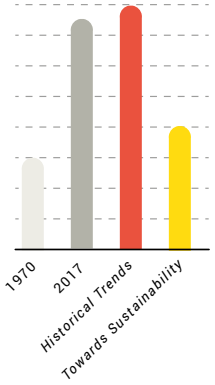
- **Methane emissions during fossil fuel extraction** have a large climate impact, with more than 1/3 of the material group (fossil extraction and processing) and 60% of fossil extraction (the latter without processing). Coal extraction alone contributes about half to these methane emissions.
- **Oil and gas extraction and processing** are responsible for 26 per cent and 27 per cent of the material group's climate change impact. Mostly, they arise from venting, flaring and local energy supply, as well as from leaks and other sources of fugitive emissions.
- Most climate change impacts of the group's emissions are caused by the **refining of crude oil** into useful products (for example chemicals, various fuels and intermediate products) and chemical production (together >60 per cent of impacts of the material group).
- Both **coal combustion and oil and gas extraction** release significant amounts of mercury into the environment (for coal this is 35 per cent of global anthropogenic emissions; for oil/gas extraction mercury is emitted with waste water and solid waste streams). These emissions are major contributors to mercury contamination in oceans.

Projected extraction in 2060 if we continue historical trends

Fossil fuel extraction in 2060 in the **'Historical Trends' scenario**:
16 billion tonnes (compared to 15 today)

Projected extraction in 2060 if we adopt concerted SCP measures today
(at net economic benefits)

Total extraction in 2060 in the **'Towards Sustainability' scenario**:
8 billion tonnes, 52 per cent less than in a historical trends scenario. Improvements in production and use efficiency would be combined with lower impact processing technologies.



Key approaches to Sustainable Consumption and Production (SCP)

Above all, fossil fuel use must be significantly decreased through use efficiency and substitution with renewable energy (as more significant climate change and particulate matter health effects occur in the use phase).

Pollutant management in extraction and processing must also be improved. This includes flaring methane and converting it to CO_2, and more innovative technologies to feeding methane into local natural gas networks or using it in gas turbines. In order to reduce impacts on human health and the environment, it is key to remove sulfur from crude oil, as it may cause acid rain and health effects from particulate matter formation during fuel combustion.

The construction of the least efficient subcritical coal power plants, which still make up the major share of new installations, has to stop.

Carbon capture and storage (CCS) can only be seen as a transition technology as it comes at the cost of efficiency losses.

Another major pollutant is plastic waste, which must be addressed through reduced use and better recycling of the material.

Biomass

Use of biomass 1970 and today (2017) (see also figure 2)

Extracted 1970 **9 billion tonnes**

Extracted 2017 **24 billion tonnes**

Biomass extraction has **increased 2.7-fold between 1970-2017**

Impacts of extraction and primary processing today (2017) - in shares of total global impact (see also figure 4)

- **17%** of global **climate change impacts**
- **07%** of global **particulate matter health impacts**
- **Over 85%** of global **water stress**
- **Over 80%** of global **land-use related biodiversity loss**

Exemplary impacts of key materials within the group (related to their extraction and processing)

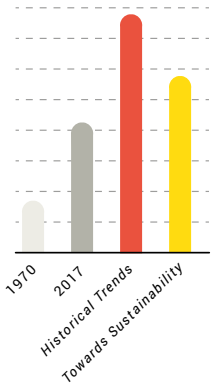
- **Cattle farming** has the highest share of climate change impacts with 26 per cent of the biomass group, mainly from enteric fermentation (i.e. CH_4 emissions) and N_2O emissions.
- **Rice production** includes the highest CH_4 emissions besides livestock and has the highest impacts from crop production.
- Climate impacts of **land use change** are difficult to allocate to sectors, potentially doubling the climate change impacts of biomass production.

Projected extraction in 2060 if we continue historical trends

Biomass minerals extraction in 2060 in the **'Historical Trends' scenario**: **44 billion tonnes** (compared to 24 today)

Projected extraction in 2060 if we adopt concerted SCP measures today (at net economic benefits)

Total extraction in 2060 in the **'Towards Sustainability' scenario**: **32 billion tonnes, 26 per cent less** than in a historical trends scenario. Improvements in production and use efficiency would be combined with lower impact extraction and processing technologies.



Key approaches to Sustainable Consumption and Production (SCP)

Key approaches on the demand side include the improvement of diets to lower global meat consumption and reduce overconsumption of food. Crop-based biofuels must be largely phased out as they compete for agricultural land.

From the production perspective, yields must be increased in many developing countries by using state-of-the art crop management, including optimized fertilization and irrigation practices. Genetically modified organisms (GMOs) must be assessed further, as they can have benefits including enhancing yields or increase resistance but can be perceived as a potential risk to humans and ecosystems. Precision agriculture, new breeds, and drone applications are promising technologies to increase biomass production efficiencies.

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Much is at stake as global society approaches the final decade before the target date for achieving the Sustainable Development Goals in 2030. The international community has set high ambitions for global prosperity, the protection of our biological diversity and land resources and limiting global warming. Progress towards these ambitions is within our grasp – but a fundamental change in how natural resources are used around the world is necessary to succeed.

The *Global Resources Outlook 2019* presents a comprehensive assessment of the connection between the most pressing environmental challenges and the extraction and processing of global resources. The assessment reinforces the International Resource Panel's central message that decoupling economic growth from resource use and its impacts must be the paradigm of a new economy that can achieve the SDGs and boost economic development. The scenarios show that concerted resource efficiency, climate mitigation and biodiversity protection measures can deliver on decoupling ambitions.

Businesses are not only key enablers in the transition to decoupling, but also need the decoupled economy for lasting business success.

The *Implications for Business Leaders* (IBL) supports businesses in using these latest findings about global resource use and impacts in strategic decision-making. This means shifting away from traditional strategy setting based on extrapolation of historical trends to 'embracing decoupling': preparing for discontinuities and disruptions and setting out to capture the new value opportunities of the shift.

This report shares case studies and practical guidance for the private sector and policymakers gleaned from frontrunners embracing the change to more resource-efficient and sustainable business models. Using the results from this report, multi-stakeholder collaboration and innovative solutions, we can resource the future we want.

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