position paper

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Bund für
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BUND
FRIENDS OF THE EARTH GERMANY

Resource protection means drastic reduction of resource consumption

Why we need to set absolute and binding resource protection targets within a resource protection framework law

BAK Waste and Raw Materials
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Content

Summary

The resource crisis is one of the greatest challenges of the 21st century and is at the root of the other two ecological crises: species extinction and climate change. More than 90 per cent of biodiversity loss and water stress are due to resource extraction and transformation, and these processes also account for about half of global greenhouse gas emissions. The fact is that we are using many times more resources than the planet can sustainably provide. But this consumption and its negative impacts are extremely unevenly distributed globally and nationally. Without drastic and absolute reductions in the extraction and consumption of resources, especially by the wealthy countries of the global North, neither the climate crisis nor the extinction of species can be stopped, let alone tackled.

The status quo and developments in recent years paint a sobering picture. It shows that previous efforts to protect resources have come to nothing. Political measures such as the German Recycling and Waste Management Act (Kreislaufwirtschaftsgesetz – KrWG), or the Resource Efficiency Programme have not led to a reduction in consumption. And this trend is not going to change. Global resource use has tripled since 1970, and a continuation of "business as usual" would mean that today's resource use would double again by 2060. In the absence of binding targets for resource protection, there is no legal framework, either at national or EU level, that could create the conditions for the necessary drastic reductions in resource use. There is a lack of international resource protection targets that are binding under international law, comparable to those of the Paris Agreement on climate protection. This makes it even more important for the German government to take the lead and finally give substance to the goal of reducing resource consumption and adapting the legal framework, as set out in the coalition agreement.

Targets are a fundamental tool of policy making. They set out a clear intention, define the scope for action and determine the direction of action. Quantifiable reduction targets enable the federal government to check whether the attempt to streamline the physical basis of the economy is successful. Quantifiable "per capita targets" make resource consumption internationally comparable and progress towards a sustainable economy with sustainable resource use measurable. For target-based measures to be fully effective, they need to be legally binding. A Resource Protection Act provides the necessary legal framework for reducing resource consumption. Therefore, BUND demands:

1. **Legislative initiative by the federal government for a Resource Protection Act in the form of an overarching framework law that defines the scope and principles of resource protection without having to rewrite all existing regulations in individual sectoral laws into a Resource Protection Code. The Resource Protection Framework Law must set measurable resource protection targets, including baseline and target years, reduction path, monitoring, sanctions and reporting requirements.**

2. **The adoption of two concrete and binding resource protection targets by the federal government:**
   - **Reduce the consumption of abiotic primary raw materials to a maximum of 6 tonnes per person per year by 2050, measured in terms of Total Material Consumption (TMC).**
   - **Reduce the consumption of biotic primary resources to a maximum of 2 tonnes per person per year by 2050, measured in TMC.**

1. Introduction

The era of economic growth is coming to an end. In this context, there is increasing talk of a "turning point in time", manifested in the war in Ukraine, but also in the corona pandemic and the distortions in the energy and commodity markets. The dimension of this "turning point" is still being ignored in large parts of the political and business communities. Many actors are only partially prepared for the new framework conditions and continue to strive for constant growth.

The transition to the post-growth era, which is long overdue, will require fundamental changes in industry, the economy and lifestyles. Overexploitation of natural resources and the overshooting of planetary boundaries will act as a brake on growth, exacerbating declining growth rates and national and global inequality.[1] If GDP growth is zero or negative, disposable incomes and hence household consumption expenditure are also likely to be reduced.

The burdens on people associated with the necessary transformations at this "turning point in time" thus force a strategy of sufficiency, i.e. an end to wasteful economics and thus less production and consumption, especially by those parts of the world's population with the highest per capita consumption of resources.[2] In order to maintain social stability, it will therefore be essential to accompany these processes with appropriate sufficiency policies and compensation for vulnerable groups.

In this context, it is important to remember that, both globally and nationally, very wealthy people are responsible for a disproportionately high share of resource consumption and therefore have a particularly high share of the necessary reductions to make. At present, 20 per cent of the world's population consume about 80 per cent of the world's resources,[3] while the poorer people have a much smaller share of resource consumption. On the other hand, these people suffer most from the negative consequences of the resource crisis. The economy and society must become permanently independent of growth. If planetary boundaries are respected, "prosperity for all" will only be possible if wealthy people reduce their environmental impact and resource consumption significantly and disproportionately compared to the less wealthy.

In the past, the path to dependence on Russian gas and oil, as well as metals and minerals from Russia and China, was economically advantageous and rational for individual companies. However, the crisis that has emerged since 2022 reveals a deficit in macroeconomic strategic planning, particularly in the area of resource policy, which has led to dependence on non-democratic regimes for the procurement of resources, which they may exploit for their own power-political purposes. Emancipation from this dependence therefore now requires both a reduction in demand and consumption and a re-regionalisation of both the supply of raw materials and the supply chains of the German and European economies, even if this increases the costs of investment and consumer goods. Cost benefits and risks can no longer be assessed on a purely individual economic basis at company level. Nevertheless, technology development and procurement policies of many companies follow old patterns, as if all raw materials were always available cheaply and in unlimited quantities, and as if they could easily be sourced from countries with low wage and low environmental standards and with no respect for human rights and the environment. But this is no longer the case, at least since the Russian invasion of Ukraine in February 2022 the window for cheap imports of raw materials without political concessions to dictators and warmongers is closing. Instead, competition for access to energy relevant raw materials, strategic metals, etc. is intensifying, and prices are rising steadily.

For this transformation into a post-growth society to succeed, it is necessary not only to balance the bur-

[1] *A full discussion of the post-growth debate would exceed the scope of this position paper. At the same time, economic growth is an important driver of resource consumption, which is why this topic is addressed in various places. For more information see https://www.oekom.de/ausgabe/postwachstum-80920 (Dossier Postwachstum des Oekom-Verlags) and the website ofBUNDjugend: https://www.bundjugend.de/thema/postwachstum/*

[2] *Further literature on sufficiency and resource use can be found at: https://www.bund.net/service/publikationen/detail/publication/perspektive-2030-suffizienz-in-der-praxis/, hier: https://www.bund.net/service/publikationen/detail/publication/mehr-lebensqualitaet-weniger-ressourcenverbrauch-argumente-fuer-suffizienz/ and here: https://www.bund.net/service/publikationen/detail/publication/die-potenziale-von-suffizienz-politik-heben/*

[3] *BUND (2014): Ressourcen schützen und respektvoll nutzen! Land – Wasser – Materialien – Atomsphäre. https://www.bund.net/fileadmin/user_upload_bund/publikationen/ressourcen_und_technik/ressourcen_schuetzen_respektvoll_nutzen.pdf*

dens on poorer and disadvantaged population groups, but also to ensure effective climate protection and the protection of global biodiversity. This will require a greatly accelerated, resource-intensive expansion of renewable energies and savings in energy and raw materials through their more efficient use and recycling. Beyond more efficient use, however, a massive reduction in energy consumption (at least a halving of current levels in the medium term)[4] and global resource consumption must be achieved.[5] Neither climate protection nor the global protection of biodiversity is possible if global resource extraction and consumption continue at the same quantitative level as before.

This all leads to the question "How much is enough?" and requires a triple strategy of efficiency, consistency and sufficiency. What is needed is a completely new resource policy with effective resource protection legislation at national and, if possible, European level.

This position paper examines these necessities and based on an analysis of the relevant prerequisites, formulates BUND's key demands on politics and industry so that this transformation can succeed. For this reason, the following presentation focuses on the discussion of resource protection targets for abiotic and biotic primary raw materials and the outlines of an appropriate legal framework. Resources such as water, air, land or soil will only be mentioned briefly, despite their high relevance for resource policy. Economic and socio-political issues are only briefly addressed but are already considered as topics for future publications. This paper is also intended to stimulate further discussion on resource conservation and possible ways of drastically reducing resource consumption, both within BUND and in exchange with policymakers and other stakeholders in business, research and civil society.

After defining the term resource, Chapter 2 provides an overview of the scope of the problem and the historical development of resource use. In Chapter 3, resource use is illustrated using examples from different policy areas. Due to the cross-cutting nature of resource policy, it was neither our intention nor realistically possible to cover all areas. In some cases, individual policy areas have already been covered in detail in other studies or in BUND positions and background papers. These sources are referred to in the introduction to Chapter 3. After an examination of the current legal framework for resource protection at national and European level (Chapter 4) and its deficits as well as possibilities for improvement, Chapter 5 is dedicated to the limits of the circular economy. The conclusion in Chapter 6 also explains why Germany and Europe need a sufficiency strategy for resource protection. From BUND's point of view, absolute and quantifiable resource protection targets are a first and important step in this direction. The derivation, indicators and design of these targets are presented in Chapter 7. Finally, the resulting demands of BUND are listed (Chapter 8).

[4] *BUND Position 66: Konzept für eine zukunftsfähige Energieversorgung. https://www.bund.net/fileadmin/user_upload_bund/publikationen/bund/position/zukunftsfaehige_energieversorgung_position.pdf*

[5] *BUND & Misereor (Hrsg.) (1996): Zukunftsfähiges Deutschland. Ein Beitrag zu einer global nachhaltigen Entwicklung. Studie des Wuppertal-Instituts für Klima, Umwelt, Energie GmbH. Birkhäuser Verlag, Basel/Boston/Berlin.*
BUND, Brot für die Welt & Evangelischer Entwicklungsdienst (Hrsg.) (2008): Zukunftsfähiges Deutschland in einer globalisierten Welt. Ein Anstoß zur gesellschaftlichen Debatte. Eine Studie des Wuppertal Instituts für Klima, Umwelt, Energie. Fischer-Taschenbuch-Verlag, Frankfurt.

2. About the background of our demands

2.1. Resource: An explanation of terms

Our definition of the term resource follows that of the German Federal Environment Agency (UBA)[6]: Resources are "renewable and non-renewable primary raw materials, physical space (or area), environmental media (water, soil, air), flowing resources (e. g., geothermal, wind, tidal and solar radiation) and biodiversity. It does not matter whether the resources serve as sources for the production of products or as sinks for the absorption of emissions (water, soil, air)".[7] We focus on primary raw materials; resources such as water, air, land and soil are not considered in this paper (despite their high relevance for resource policy) or are only briefly mentioned. For this, we refer to other studies and position papers.

2.2. Resource use: historical development and projections

All economic activity directly or indirectly uses natural resources and generates waste and waste heat to produce food, goods and services, infrastructure and means of communication for our daily use. This has always been the case: Stone Age hunters and gatherers used the resources of their environment for food, clothing and building materials. The farmers of the Neolithic Revolution modified the ecosystems around them, selecting flora and fauna according to the characteristics of certain plants and animals that were advantageous to them. In addition, as early as the Stone Age, but increasingly since the Copper and Bronze Ages, people began to mine metallic and mineral resources to make tools, weapons, jewellery and other items of daily use. Traces of lead in the Greenlandic ice sheet show the peaks of mining activity during the Phoenician and Roman periods, the late Middle Ages and various periods of crisis. Until the Industrial Revolution, biomass and minerals were used almost exclusively as sources of construction materials, while biomass, hydroelectric power and wind were used as sources of energy.

Carl von Carlowitz's concept of sustainability[8] in forestry in 1713[9] also dates back to the unrestrained use of natural resources when, as a result of the mining and smelting of silver in Saxony, the high consumption of wood from the local forests led to deforestation and a resulting shortage of wood. In other words, providing people with goods has always involved environmental interventions for the purpose of exploiting resources. Since the beginning of the industrial revolution, the scale and consequences of these environmental interventions have steadily increased and become more pronounced and visible, in part because the consumption of non-renewable finite resources, such as coal and later oil/natural gas, has developed in parallel with the technical possibilities for their extraction and use.

Since then, resource consumption has risen continuously. This is because the Industrial Revolution also changed the perception of resource availability, from an economy with limited resources to one with unlimited resources. This has fostered what some scientists now call "the Great Acceleration".[10] The annual amount of raw materials[11] extracted has multiplied; from 1970 to today the global extraction of raw materials has almost quadrupled. The increasing use of raw materials has also increased carbon dioxide emissions and thus contributed to the climate crisis. And this presumption is not shaken even in crisis situations, for example when, faced with an acute shortage of natural gas, industry is not primarily looking for ways to save energy but for new suppliers. Or when the mobility transition that is regarded as necessary does not consist of reducing car traffic and driving fewer kilometres, but rather, with the number of vehicles continuing to rise and more and more kilometres being driven, results in discussing different drive systems, and alternative fuels for aircrafts. The same applies to the current plans for Carbon Capture and Storage (CCS)[12], which are not an alternative to avoidance and reduction of emissions in the industrial sector and therefore lead to a wrong course in the direction of "business as usual". From BUND's point of view, the orientation towards a CCS economy and an industrial CCS infrastructure must therefore be

6 Umweltbundesamt (Hrsg.) (2012): Glossar zum Ressourcenschutz. Dessau-Roßlau. https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4242.pdf, S. 21.

7 The resources water, soil, air and land will not be discussed further in this position paper, despite their high relevance for resource policy. This is because the focus is on resource protection targets for non-renewable and renewable primary resources.

8 ZFor the BUND definition of sustainability, see https://www.bund.net/ueber-uns/nachhaltigkeit/

9 von Carlowitz, H. C. 1713. Sylvicultura oeconomica oder Anweisung zu wilden Baum-Zucht. Leipzig, Johann Friedrich Braun.

10 Bundeszentrale für politische Bildung (2016): Zum Entwicklungsverlauf des Anthropozäns: 'Die Große Beschleunigung'. https://www.bpb.de/themen/umwelt/anthropozaen/234831/zum-entwicklungsverlauf-des-anthropozaens-die-grosse-beschleunigung/

11 Includes raw materials (excluding water and air) extracted from the natural environment for use in economic activities. Measured and aggregated in tonnes.

12 View BUND Position 75: Geoengineering decisively rejected. It is precisely this focus on technical feasibility that enables "business as usual" without any change in behaviour and prevents solutions.

What would a continuation of these trends under a 'business as usual' strategy mean? Resource use would double again by 2060. The associated impacts do not even consider the effort required to remove the ecologically highly problematic tailings from mining operations, which are generated in particular by the extraction of metallic and some fossil raw materials. These tailings, as a consequence of mining, will increase disproportionately in the future, as the concentration of ore will continue to decrease after the exploitation of the most economically viable deposits, and the amount of tailings per tonne of extracted ore will continue to increase.

As with all limited, non-renewable resources, once extraction has reached a maximum, any further extraction will require ever greater effort – with corresponding costs, including environmental costs. This is described by the Hubbert curve.[13] It is clearly visible, for example, in the case of natural gas, which has to be extracted from deep layers of the earth or rock using toxic chemicals in a process known as fracking.

To compound the problem, many of the so-called future technologies also have a massive demand for raw materials when they come into general use. Projections show that technologies such as e-mobility, digitalisation, consumer electronics, defence equipment, and renewable energies such as solar and wind power would lead to a massive increase in demand for critical minerals and metals (e.g. copper or cobalt), assuming unchanged overall economic growth.[14] Although predictions about the supply of metals have mostly been wrong, there is no doubt that these are finite resources which will be exhausted at some point.

Most metals are in theory well suited for recycling. However, this requires that they can be separated by type from the scrap fraction. For products that contain a wide variety of metals in very small quantities, such as electronic equipment, this is currently not possible for economic reasons. Regardless of the economic constraints, the very low concentrations of metals lead to material dissipation during recovery and thus to an irretrievable loss of material. The increasing miniaturisation and incorporation of electronic components in household appliances and other objects exacerbates this problem.

Even in the case of large, metal-containing household and industrial waste, sorting by type is a necessary requirement for obtaining a secondary alloy of the same quality grade as the primary alloy. If, as is often the case, this is not achieved, the scrap can either only be used as an addition to a fresh melt of primary material, or it is downcycled to a lower quality material. But even if the scrap is collected by type, the subsequent melting process changes the chemical composition as individual elements are combusted or picked up, which in turn must be corrected by adding small amounts of primary material. The more complex the alloy chemistry of the primary material, the more severe the effect of this change in chemical composition. One hundred percent recycling, defined as the exact replacement of primary material with secondary material (i.e. scrap) in terms of quality and quantity, is not yet feasible, even for metals, for the reasons mentioned above.

Similarly, with current business practices in supermarkets and online retailing and the strong growth of these distribution methods in less industrialised countries, as well as new applications for plastics and synthetics in other areas, global plastics production continues to increase. The chemical industry currently projects that current plastics production will triple by 2050.[15] The question of whether and where the residues left over at the end of use can be disposed of or reused without increasing the already heavy burden of plastic waste on the environment is still completely unresolved.

13 https://de.wikibrief.org/wiki/Hubbert_curve

14 The compatibility of the energy and resource transitions is demonstrated by two studies presented by PowerShift in January 2023.: https://power-shift.de/pm-ausbau-der-erneuerbaren-energien-ist-kein-treiber-fuer-bergbau/

15 nova-Institut (2021): World Plastic Production and Carbon Feedstock – in 2018 and Scenario for 2050 (in million tonnes). https://renewable-carbon.eu/publications/product/world-plastic-production-and-carbon-feedstock-in-2018-and-scenario-for-2050-graphic/

In the current economic system, resource waste is inherent in the system because much of the costs associated with the extraction of raw materials, the consumption of resources and their final disposal are not charged to the mining company, the manufacturer of the products or the individual consumer, but are instead paid for by society, the environment or uninvolved third parties. The costs to be paid by producers and consumers are therefore often too low to reflect the true impact of the use and consumption of these resources. At the individual level, producers and consumers have little or no economic incentive to use resources responsibly, since it is often cheaper to throw things away and simply buy new ones than to repair them, recycle them or dispose of them in such a way that they can be reused as secondary raw materials. The economic logic and the socialisation of the consequential costs have therefore led to a systemic waste of resources (keywords: Throwaway mentality, linear economy from pit to landfill or waste incineration).

Since complete recycling is not possible, the objective must be to minimise the use of resources and to optimize the usage of already extracted resources by reusing, repairing, or reprocessing.

2.3. Resource consumption growth and limits

In physics, we know that energy cannot be created or destroyed – it is merely converted into other forms of energy, of which some are more usable for human purposes, but a proportion is always released into the environment as unusable heat. Therefore, industrial processes are not reversible, because for every chemical-physical conversion to obtain material or energy, heat or material matter is "lost" for further use. In addition, energy is always required for recycling, which must also be considered in the overall balance of environmental impact and resource use.[16]

It is essential to remember that material resources on Earth are finite and the planet is almost a closed system. Therefore, infinite and permanently unlimited growth is impossible. Economies focused on growth are not balanced, but in a temporary and precarious state only sustained by a continuously growing supply of extracted materials and energy. Without countermeasures, the system will sooner or later collapse if the supply of extracted materials and energy fails or decreases. The current economic theory, focused on growth, wrongly presumes that developments and processes are reversible and infinitely scalable, as it does not consider the resource availability or the guaranteed losses in any recycling process.

To tackle climate change and biodiversity loss and prevent system collapse, policymakers and society need to recognise the limits of the Earth's systemic capacity and promote economic practices that reduce the overall consumption of resources in an absolute and drastic way and ensure that the remaining resources are used in a sustainable way. To tackle climate change and biodiversity loss and prevent system collapse, policymakers and society need to recognise the limits of the Earth's systemic capacity and promote economic practices that reduce the overall consumption of resources in an absolute and drastic way and ensure that the remaining resources are used in a sustainable way.

We need to restructure and manage consumption on both supply and demand sides, e.g. by increasing the price and limiting the quantity of primary raw materials on the input side. Rockström et al. introduced the concept of "Planetary Boundaries" in 2009.[17] These define so-called "safe operating spaces" in nine different thematic areas, including climate change, biodiversity loss and freshwater use. The "Planetary Boundary" for biodiversity loss had already been exceeded at that date. The planetary boundary for "new substances and modified life forms"[18] was not quantified until 2021 The study by Persson et al.[19] concludes that environmental pollution by hazardous and persistent chemicals is already out of control. We have already exceeded the 'safe operating space' and ecosystems around the world are threatened by new

16 Rebane, K. K. (1995): Energy, entropy, environment: why is protecting of the environment objectively different? Ecological Economics 13(1): 89-92. Ausführlich in: Lehmann, H.; Hinske, C.; de Margerie, V.; Slaveikova Nikolova, A. (Hrsg.) (2022): The impossibilities of the Circular Economy. Separating Aspirations from Reality. Routledge, London.

17 Rockström, J., Steffen, W., Noone, K. et al. (2009): A safe operating space for humanity. Nature 461, 472–475. https://doi.org/10.1038/461472a.

18 These include plastics, chemicals, pesticides, metals, radioactive materials and genetically modified organisms.

19 Persson, L.; Carney Almroth, B. M.; Collins, C. D.; Cornell, S.; de Wit, C. A.; Diamond, M. L.; Fantke, P.; Hassellöv, M.; MacLeod, M.; Ryberg, M. W.; Søgaard Jørgensen, P.; Villarrubia-Gómez, P.; Wang, Z.; Hauschild, M. Z. Outside the Safe Operating Space of the Planetary Boundary for Novel Entities. Environ. Sci. Technol. 2022, 56 (3), 1510–1521. https://doi.org/10.1021/acs.est.1c04158.

substances such as synthetic chemicals and plastics. A further quantification of the impacts of resource extraction in relation to "planetary boundaries" is the subject of ongoing research.

3. Resource policy and other policy areas

In the following, the use of resources will be considered under the conditions of a transition in mobility, construction, chemistry and energy, as well as under the influence of digitalisation, in which in particular fossil energy sources will be replaced by renewable energy sources, which in return may lead to a significant increase in the use of certain raw materials. Other policy areas such as agricultural policy[20], the bioeconomy[21] and the use of bioplastics[22] have already been comprehensively addressed in other BUND studies, position papers and background papers. The dramatic consequences of wasteful resource use, such as marine litter[23] or deep-sea mining[24], have also been covered in detail elsewhere.

The resource crisis is the third major ecological crisis of our time, next to the climate crisis and species extinction. Wasteful use of resources is proven to be the main driver of the other two crises. If humanity wants to achieve the priority targets set by international agreements to limit global warming and stop the loss of biodiversity, it must drastically change the use of resources and, in particular, significantly reduce their extraction and consumption. About half of greenhouse gas emissions are caused by the extraction, supply and processing of resources.[25] Not only the extraction of raw materials from nature is a harmful intervention and leads to the release of greenhouse gases, but also the further processing and use of raw materials requires the use of energy (today mainly fossil energy) and therefore leads to the emission of greenhouse gases.

More than 90 percent of the current loss of biodiversity is related to the production, extraction and processing of resources and the resulting loss of habitats and ecosystems.[26] The conditions for growing the feedstock for a 'bio-based' economy, within the context of industrial agriculture and without drastically reducing resource use, are causing negative impacts on ecosystems, species and human communities, and create competition between nature conservation and food production.

3.1. Mobility

The production of an average 1.5 tonne car consumes 70 tonnes of materials and resources. The manufacturing process alone accounts for 15 to 20 percent of all CO_2 emissions during the entire lifecycle of a car.[27] In addition, the number of registered cars in Germany has risen steadily in recent years to around 48 million in 2019. At the same time, there has been a steady increase in weight and engine power of these cars over the past decades.

According to the Federal Environment Agency, around 3.12 million passenger cars were finally taken out of service in Germany in 2019. However, only 0.46 million of these ended up in German dismantling and shredding facilities. In these recycling facilities, only 18 percent of the material components of each vehicle are recovered (including metal, tyres, batteries, catalytic converters, glass, oil filters). The much larger share of about 2.5 million end-of-life vehicles was exported.[28] Although these vehicles are reused abroad, their final fate in terms of recycling or disposal is neither traceable nor controllable.

To meet climate targets in the transport sector by 2030, a large number of future cars will need to be powered by renewable energy. There are currently three options under discussion: the electric car with a battery, the electric car with a hydrogen-powered fuel cell, and the use of so-called synthetic fuels produced with the help of electricity.

The most efficient of the alternative drive systems is by far the battery electric car. The advantage in terms of efficiency is the direct use of electricity by the electric motor, which is three times more efficient than an internal combustion engine. The efficiency decreases the more the electricity is converted into other energy sources. A battery electric vehicle has an efficiency of about 77 percent, compared to a fuel cell vehicle (33 percent) and a vehicle that burns e-fuels (13 percent).

20 BUND Position 73: Zukunftsfähige Landwirtschaft – umweltverträglich, tiergerecht, sozial. https://www.bund.net/service/publikationen/detail/publication/zukunftsfaehige-landwirtschaft-umweltvertraeglich-tiergerecht-sozial/

21 More information about this is available here: https://www.bund.net/ressourcen-technik/biooekonomie/

22 BUND Hintergrund "Bio"-Kunststoffe. https://www.bund.net/service/publikationen/detail/publication/bio-kunststoffe/

23 BUND Position 71: Meeres- und Küsten-naturschutz der Nord- und Ostsee. https://www.bund.net/service/publikationen/detail/publication/positionen-zum-meeres-und-kuestennaturschutz-der-nord-und-ostsee/

24 Position 67 BUND: Tiefseebergbau. https://www.bund.net/service/publikationen/detail/publication/tiefseebergbau/

25 UNEP/IRP (2019). Global Resource Outlook 2019. Natural resources for the future we want. Summary for Policymakers. https://www.resourcepanel.org/reports/global-resources-outlook

26 UNEP/IRP (2019). Global Resource Outlook 2019. Natural resources for the future we want. Summary for Policymakers. https://www.resourcepanel.org/reports/global-resources-outlook

27 VCÖ (2023): Wie viele Ressourcen werden bei der Pkw–Produktion verbraucht? https://vcoe.at/service/fragen-und-antworten/wie-viele-ressourcen-werden-bei-der-pkw-produktion-verbraucht

28 Umweltbundesamt (2023): Altfahrzeugverwertung und Fahrzeugverbleib. https://www.umweltbundesamt.de/daten/ressourcen-abfall/verwertung-entsorgung-ausgewaehlter-abfallarten/altfahrzeugverwert

Battery electric drives are therefore an important way of reducing CO_2 emissions in the transport sector. However, there is a double resource problem: Does the production of batteries increase CO_2 emissions and thus change the overall balance? And: What will be the impact of the additional use of critical raw materials?

As early as 2009, BUND came out in favour of electric cars in its position paper "Für zukunftsfähige Elektromobilität: umweltfreundlich, erneuerbar, innovativ"[29] (For sustainable electromobility: environmentally friendly, renewable, innovative) and claimed that they should be powered "with electricity from additional renewable energy plants", that the size of the vehicles should be reduced and thus their weight (downsizing), and that the reuse and recycling of batteries after their first use should be substantially expanded. In addition, BUND demanded that electric cars must replace vehicles with combustion engines and not simply contribute to the further expansion of vehicle fleets by adding more electric cars as second cars.

The most important factor in the life cycle assessment is the so-called "break-even point". This is the point at which the production of the battery in operation compensates for the slightly higher environmental footprint of the electric car (in terms of greenhouse gas emissions) and the car starts to save CO_2. According to a study by the Fraunhofer Institute, this depends not only on the production location, but also on the size, or more precisely, the capacity of the battery. If you choose a small battery (say 40 kWh), a medium sized battery electric vehicle (BEV) will need to drive about 52,000 km to achieve a positive carbon footprint compared to a comparable petrol vehicle. In this case, greenhouse gas emissions are reduced by 32 percent over the entire lifetime of the vehicle. The distance would have to be around 100,000 km for the luxury car with 120 kWh battery capacity.[30] These results are also confirmed by the Öko-Institut: In order to overcompensate for the additional emissions during production in the overall lifecycle emissions balance, a relatively intensive use of electric cars is necessary.[31]

However, it is true that a large proportion of batteries are currently manufactured in China. Much of the energy used to produce these batteries is generated from coal, resulting in high CO_2 emissions in the manufacturing phase. It is also true that an electric car requires significantly more critical raw materials than a combustion engine car. According to the International Energy Agency (IEA)[32] on average more than 200 kilograms of raw materials such as copper, lithium, nickel, manganese, cobalt, graphite and rare earths are required to produce the drive unit of an electric car, whereas a car with a combustion engine "only" requires between 30 and 40 kilograms of copper, manganese and very little graphite. These orders of magnitude become much more relative if, instead of looking at the drive unit, we consider the entire car and its material footprint. If the use phase is included, a combustion engine requires an additional 61,000 litres of crude oil.[33] At present, only lithium-ion batteries are suitable for electric cars because of the high energy density required. But even here, battery technology is constantly improving.[34]

Lithium is extracted to a large extent from salt lakes by water-intensive evaporation, which implies a serious intervention in the ecology of this habitat. Alternatively, lithium can be extracted from solid rock using much less water. However, the CO_2 emissions from this method are much higher due to the fact that the extraction process is much more complex. When planning a mining operation, it is important to make an accurate assessment of the socio-environmental impact. In addition, it is essential to ensure that individual cells of the batteries can be repaired and replaced, as well as to provide solutions for their further reasonable use or reuse after their lifetime in a vehicle (e.g. to store the electricity generated). If

29 BUND (2009): Für eine zukunftsfähige Elektromobilität: umweltverträglich, erneuerbar, innovativ. https://www.bund.net/service/publikationen/detail/publication/fuer-eine-zukunftsfaehige-elektromobilitaet-umweltvertraeglich-erneuerbar-innovativ/

30 Wietschel, M. (2020): Ein Update zur Klimabilanz von Elektrofahrzeugen. Working Paper Sustainability and Innovation. Fraunhofer ISI, Karlsruhe, S. 13.

31 Umweltbundesamt (Hrsg.) (2016): Weiterentwicklung und vertiefte Analyse der Umweltbilanz von Elektrofahrzeugen. Dessau-Roßlau. https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_27_2016_umweltbilanz_von_elektrofahrzeugen.pdf UPI-Institut (2019): "Ökologische Folgen von Elektroautos – Ist die staatliche Förderung von Elektro- und Hybridautos sinnvoll?", UPI-Bericht 79, 3. aktualisierte Auflage. Heidelberg. https://www.upi-institut.de/UPI79_Elektroautos.pdf Öko-Institut (2018): Elektromobilität – Faktencheck. Fragen und Antworten. Berlin. https://www.oeko.de/fileadmin/oekodoc/FAQ_Elektromobilitaet_Oeko-Institut_2017.pdf Agora Verkehrswende (2019): Klimabilanz E-Autos. Einflussfaktoren und Verbesserungspotenzial. Berlin. https://www.agora-verkehrswende.de/fileadmin/Projekte/2018/Klimabilanz_von_Elektroautos/Agora-Verkehrswende_22_Klimabilanz-von-Elektroautos_WEB.pdf

32 IEA, The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions, Paris 2020.

33 DUH (2023): Wie umweltverträglich sind Elektroautos. DUH Infopapier. Radolfzell/Berlin. https://www.duh.de/fileadmin/user_upload/download/Projektinformation/Kreislaufwirtschaft/Batterien/230201_Umweltvertraeglichkeit_Elektroautos.pdf

34 The company CATL has announced a sodium-ion battery for 2023 that does not require cobalt, nickel or lithium.

these consumption calculations are based on the current sales figures of the automotive industry, however, a new study by PowerShift[35] shows the following scenario: In 2030, almost 800,000 tonnes of aluminium, 250,000 tonnes of nickel and 130,000 tonnes of copper would be needed for the batteries alone to produce an electric Volkswagen fleet. According to this projection, Volkswagen would require ten times as much nickel and aluminium in 2030 as the entire planned expansion of wind power in Germany.

The transition to sustainable mobility must therefore be about much more than alternative technological solutions for private individual mobility based on electric drives. From BUND's point of view, individual car traffic and freight traffic on the roads must be significantly reduced (by at least 50 per cent by 2040), in terms of the number of vehicles, their size and weight, and the kilometres driven. On the other hand, the share of public transport, bicycle and pedestrian mobility as well as rail-bound freight transport must be significantly increased.

From a resource perspective, BUND demands the following measures from industry and politics.

- Car downsizing: significantly smaller and lighter cars instead of large SUVs,
- Progressive taxation of vehicles with higher fuel consumption
- Reducing the number of cars by
  - Expansion of the public transport system with regular and frequent services
  - Attractive pricing of public transport, low threshold offers for interregional use
  - Expansion of safe and continuous cycling and walking networks
  - Consistent freeing of cycle paths and footpaths from stationary traffic and other obstacles caused by unrelated uses.

3.2. Energy

As part of the energy transition, BUND supports the implementation of sufficiency and energy efficiency and the goal of 100 % renewable energy supply[36], particularly with a view to reducing resource consumption in the energy sector. An immense reduction in the consumption of fossil and nuclear resources for energy, energy carriers and power plants is countered by an additional demand for new resources. The study "Wege zum klimaneutralen Energiesystem" (Pathways to a Climate-Neutral Energy System)[37] gives a very good picture of how the change in energy sources can take place in the "Sufficiency" scenario. The Wuppertal Institute[38] has analysed the areas of resource use and came to the following conclusions. According to the current state of research, the following areas are not critical:

- **Use in the electricity sector: hydropower[39], wind turbines without rare earth magnets, silicon-based crystalline photovoltaics.**
- **Use in the heat sector: geothermal, solar thermal, solar and geothermal power plants**
- **Infrastructure: electricity grids, various types of electricity storage, alkaline electrolysis and SOFC fuel cells**

Potentially critical areas in terms of resource use

- **Use of rare earths for magnets in the wind energy sector**

Neodymium (Nd) and dysprosium (Dy) are used in permanent magnets in some wind turbine generators, particularly offshore wind turbines.[40] Currently, the share of offshore wind turbines is about 15 per cent (8 GW).[41] The problems are not only the dependency on imports (more than 95 per cent come from China), but also the environmental impact of mining, and not least the working conditions. Because of these problematic aspects, which also include the risks to maritime ecosystems, BUND is calling for the expansion of offshore wind energy to be limited to a maximum of 15 GW, in opposition to the targets set by

35 PowerShift (2022): Metalle für die Energiewende – Warum wir die Rohstoffwende und die Energiewende zusammendenken sollten. Berlin. https://power-shift.de/wp-content/uploads/2022/11/Metalle-fA%C2%BCr-die-Energiewende_web_17112022.pdf

36 BUND Position 66: Konzept für eine zukunftsfähige Energieversorgung. https://www.bund.net/fileadmin/user_upload_bund/publikationen/bund/position/zukunftsfaehige_energieversorgung_position.pdf

37 Fraunhofer ISE (2020): Wege zu einem klimaneutralen Energiesystem. Die deutsche Energiewende im Kontext gesellschaftlicher Verhaltensweisen. Freiburg. https://www.ise.fraunhofer.de/content/dam/ise/de/documents/publications/studies/Fraunhofer-ISE-Studie-Wege-zu-einem-klimaneutralen-Energiesystem.pdf

38 Vgl. Projekt KRESSE: Kritische mineralische Ressourcen und Stoffströme bei der Transformation des deutschen Energieversorgungssystems, https://wupperinst.org/p/wi/p/s/pd/38/.

39 However, especially in the case of small-scale hydroelectric power plants (in running waters), the cost of materials is often disproportionate to the amount of electricity generated. They also involve many other environmental risks. BUND therefore rejects them. Further information in BUND position 54: Wasserkraftnutzung unter der Prämisse eines ökologischen Fließgewässerschutzes https://www.bund-naturschutz.de/fileadmin/Bilder_und_Dokumente/Themen/Energiewende/Erneuerbare_Energien/BN-Position-Wasserkraftnutzung-54_2016.pdf and under: https://www.bund.net/energiewende/erneuerbare-energien/wasserkraft/

40 Glöser-Chahoud, S.; Pfaff, M.; Tercero Espinoza, L.; Faulstich, M. (2016):Dynamische Materialfluss-Analyse der Magnetwerkstoffe Neodym und Dysprosium in Deutschland. Erschienen in: 4. Symposium Rohstoffeffizienz und Rohstoffinnovationen, Tutzing, 17./18. Februar 2016, herausgegeben von Ulrich Teipel und Armin Reller, Fraunhofer Verlag. https://www.windland.ch/wordpress/wp-content/uploads/Material flussanalyse_Gloeser_et_al.pdf

41 BMWK (2023): Erneuerbare Energien. https://www.bmwk.de/Redaktion/DE/Dossier/erneuerbare-energien.html the German government.[42] The necessary expansion of wind energy therefore can and should take place primarily without the use of rare earths. In addition, recycling systems must be set up for the main applications of these metals (especially permanent magnets in motors). The large and durable permanent magnets used in wind turbines are relatively easy to recycle.[43]

- **Use of materials for the expansion of wind energy**

A large proportion of the materials used in wind turbines can be recycled.[44] While concrete accounts for about 80 per cent and steel for about 15 per cent of a turbine's mass, the fibreglass materials used in the blades of the turbines contribute only about one per cent of the total mass. These GRP materials are currently recycled into energy in waste incineration plants, especially as only small amounts of residual materials from the demolition of wind turbines have been generated in the last few decades. In the future, it will be important to develop recycling capacities and processes for all parts of a wind turbine and, where necessary, to include recyclability as a design criterion in approval procedures.

- **Use of materials in photovoltaics**

Silicon, as the main material for photovoltaics, can probably be classified as uncritical in terms of extraction. It is extracted from silica sand, currently mainly in China, Russia and the USA. Most of it is used in chip production, which is also the cause of the price surges and supply problems. However, there are repeated reports of forced labour and serious human rights abuses associated with the extraction and production of polysilicon in China. This is why the politically binding nature of a strong supply chain law must be emphasised at this point (more on this in section 4.2).
The Wuppertal Institute has analysed the use of photovoltaics regarding the consumption of indium, gallium, selenium, silver, cadmium and tellurium (KRESS project, op. cit.).[45] Silicon-based photovoltaic cells are considered uncritical from a resource point of view. A recycling system (PV Cycle) has been in place since 2010 and has been regulated by the EU WEEE Directive since 2014 and by the German Electrical and Electronic Equipment Act (ElektroG) since 2015. The focus is on the recovery of metals such as aluminium and copper. DUH has set out concrete demands for improvement by 2021.[46] A study by PowerShift on the expansion of recycling in the renewable energy sector also points to a large number of recent examples of improvements which are already being implemented by start-ups.[47]

- **Materials and elements for storing electricity in batteries**

As wind and solar power generation is intermittent, storage is becoming increasingly important to ensure a reliable and consistent supply of electricity. Battery storage helps to stabilise electricity produced by photovoltaics and avoids overloading the grid. Electricity can additionally be stored in batteries for electric vehicles.

Meanwhile, there are also electricity storage systems that work (almost) without the use of metals. Storage systems based on salt water have also been developed.[48] In 2022, the production of batteries using tree lignin based on vanillin began.[49] However, it is not yet possible to make a definitive statement about the resource savings of such designs compared to other storage systems.

However, electricity storage with a liquid medium as "redox flow storage" based on vanadium must be viewed critically due to its chemically aggressive properties in the event of accidents, its competitive use in tool steels and its limited availability from China, South Africa and Russia.[50]

In conclusion, the energy transition can lead to increased consumption of materials that are critical

42 BUND (2023): Offshore-Windenergie: Klimaschutz nur mit Meeresnaturschutz. https://www.bund.net/energiewende/erneuerbare-energien/windenergie/offshore-windenergie/
43 PowerShift (2023): Rohstoffwende und Energiewende zusammen denken. Kreislaufführung von Erneuerbaren Energien ausbauen. Berlin. https://power-shift.de/wp-content/uploads/2023/01/PS_066_Studie_Kreislaufwirschaft_v13_Web.pdf
44 Umweltbundesamt (2020): Windenergieanlagen: Rückbau, Recycling, Repowering. https://www.umweltbundesamt.de/themen/abfall-ressourcen/produktverantwortung-in-der-abfallwirtschaft/windenergieanlagen-rueckbau-recycling-repowering Umweltbundesamt (Hrsg.) (2019): Entwicklung eines Konzepts und Maßnahmen für einen ressourcensichernden Rückbau von Windenergieanlagen. Texte 117/2019, Dessau-Roßlau. https://www.umweltbundesamt.de/publikationen/entwicklung-eines-konzepts-massnahmen-fuer-einen
45 View Project KRESSE: Kritische mineralische Ressourcen und Stoffströme bei der Transformation des deutschen Energieversorgungs systems, https://wupperinst.org/p/wi/p/s/pd/38/.
46 DUH (2021): Kreislaufwirtschaft in der Solarbranche stärken. Alte Photovoltaik-Module für den Klima- und Ressourcenschutz nutzen. Weißbuch zur Stärkung der Wiederverwendung und des Recyclings von Photovoltaik-Modulen. Radolfzell/Berlin. https://www.duh.de/fileadmin/user_upload/download/Pressemitteilungen/Kreislaufwirtschaft/210310_Wei%C3%9Fbuch_Kreislaufwirtschaft_Solarmodule_st%C3%A4rken_DEU_FINAL.pdf
47 PowerShift (2023): Rohstoffwende und Energiewende zusammen denken. Kreislaufführung von Erneuerbaren Energien ausbauen. Berlin. https://power-shift.de/wp-content/uploads/2023/01/PS_066_Studie_Kreislaufwirschaft_v13_Web.pdf
48 BlueSky Energy, the company that pioneered this principle, was forced to file for bankruptcy in the autumn of 2022. https://elektro.at/2022/09/27/insolvenz-aus-fuer-salzwasserspeicher-hersteller-bluesky-energy/
49 CMBlu (2023): Organic-SolidFlow-Energiespeicher. Die Natur ist unser Vorbild. https://www.cmblu.com/de/ueber-uns/
50 View Project KRESSE: Kritische mineralische Ressourcen und Stoffströme bei der Transformation des deutschen Energieversorgungssystems, https://wupperinst.org/p/wi/p/s/pd/38/.

to the resource base. In the field of solar and wind energy, on the other hand, there are good alternatives that do not use critical materials. However, there is still no national or European accounting of the consumption of these materials/elements.

3.3. Housing and Construction

The construction sector is currently responsible for the consumption of 50 per cent of all extracted raw materials. Recycling of demolition materials has so far been inadequate, if at all. With a raw material input of 321 million tonnes per year, the construction industry is the economic sector with the highest resource consumption in Germany and, with more than 200 million tonnes of waste per year, is responsible for more than half of the annual waste generation. Therefore, increasing the recycling of building materials is a key factor. The end of a building's life and the reuse of materials should therefore be considered in planning and construction of existing and new buildings. In addition, all future construction activities should be carried out at a high ecological level.

Reuse of materials is always preferable to recycling, which itself consumes energy. Some insulation materials can be recycled without further treatment. Modular construction methods need to be more commonly used in the construction industry in order to make construction recycling practicable without the need for renewed use of resources. Not all of the materials that are made from renewable raw materials are automatically more environmentally friendly throughout their entire value chain.

The construction industry must be obliged to apply the highest standards of energy efficiency and to use sustainable and non-toxic building materials. In the future, the environmental and energy impact of buildings should be considered throughout their whole lifecycle, i.e. even before approval by authorities. The so-called "grey energy", i.e. the energy "embodied" in building materials (i.e. the energy used for their extraction and production), is in many cases already equivalent to the amount of energy consumed during their entire use. This means that buildings designed for longer lifetime and therefore for sustainability can also make an important contribution to climate protection. The German government and the EU are called upon to establish recovery and recycling-friendly constructions as a standard in building law. Buildings can also become CO_2 storage facilities themselves through the long-term use of renewable raw materials such as wood. The inclusion of grey energy and grey emissions must therefore be anchored in the German Building Energy Act (GEG).

A significant contribution to the necessary reduction in resource and land consumption in the building sector can only be achieved through the conversion, extension, change of use and renovation of existing buildings. There is also a need to rethink the size of the residential and commercial space used. From 1998 to 2021, per capita living space in Germany increased from an average of 39 to almost 48 square metres.[51] A reduction in per capita living space would already cover a large proportion of the demand for housing by 2040.[52]

It is also essential to ensure the high quality processing and reuse of construction waste from deconstruction and demolition as secondary building materials. Targeted investigation and selective demolition of existing buildings not only improves the identification of potentially recyclable materials. It also provides an opportunity to use directly recyclable components.

Construction waste from deconstruction or demolition needs to be processed to a high standard and the utilisation of secondary materials obtained in this way needs to be increased.

Mineral waste from the construction industry, which is generated in large quantities during the demolition

[51] *Umweltbundesamt (2022): Wohnfläche. https://www.umweltbundesamt.de/daten/private-haushalte-konsum/wohnen/wohnflaeche*

[52] *Bauwende e. V. (2020): Wohnflächen-Effizienz: Klimaschutz und mehr mit dem Probound-Effekt. https://bauwende.de/wp-content/uploads/2020/10/BAUWENDE-Factsheet-Wohnfl%c3%a4chen-Effizienz-2020_2.pdf*

of buildings, is currently used in particular in civil engineering, for backfilling or as substructure for roads. These recycling routes need to be developed in favour of the wider use of high quality secondary building materials in construction. The german "Ersatzbaustoffverordnung" (Substitute Building Materials Regulation), which will come into force in August 2023, could have contributed to this, but lags behind.

However, there is still a need to review building regulations in order to make demolition material safer for reuse in residential buildings (e.g. mandatory sampling of demolition material for use as a raw material). In addition, the development of markets for demolition and secondary raw materials needs to be supported, such as by regional collection centres and the provision of temporary storage areas under public law.

New technologies, such as carbon-cement composites, should be tested, as they offer better material properties and savings, but may have a lower performance in terms of deconstructibility and recyclability.

Urban green and blue infrastructure must be integrated into the planning process in a stronger and more binding way than conventionally structured residential and commercial areas. The objective must be: To minimise the use of land for residential, commercial and transport infrastructure. In order to achieve "net zero" by 2030, new land-use must be drastically reduced. This implies that any additional sealing should be compensated by deconstruction and unsealing no later than 2030.

A general educational campaign should be launched, particularly in the academic sector where, for example, resource efficiency is a minor topic in the architectural curriculum. The nationwide promotion of projects using alternative building materials and methods for deconstruction as well as the reuse of building components should also be encouraged. The architects' fee structure needs to be adjusted to ensure that resource-saving designs become an attractive option.

Further considerations for a social-ecological transition in housing and construction can be found in a policy briefing paper by the civil society network "Ressourcenwende".[53]

3.4. Digitalisation

The term 'digitalisation' or 'digital transformation' describes the technological and social changes resulting from digital technologies. The German Advisory Council on Global Change (Wissenschaftlicher Beirat für Globale Umweltveränderungen – WBGU) defines the key aspects of digitalisation as networking, autonomy, virtuality, and knowledge exposure.[54] This transformation has major implications for society and the economy, as well as for technologies, and is exacerbating existing developments such as the resource crisis.

Recent studies, including the study by the German Raw Materials Agency (DERA) on Future Technologies 2021, indicate an increase in demand for all 14 primary raw materials considered for so-called future technologies.[55] These future technologies include all areas of what is called "Industry 4.0", where digital technologies are used in production and products – including the already highlighted areas of electromobility and energy transition, as well as the necessary infrastructure such as data centres, fibre optic cables and the expansion of the power grid.

The growing demand for semiconductors or chips is also leading to a massive increase in demand for metallic resources.

In particular, the industrialised countries of the 'global north' benefit from these future technologies,

53 Jacobs, B. (2022): Wir brauchen eine sozial-ökologischen Wohn- und Bauwende. https://www.ressourcenwende.net/blog/wir-brauchen-eine-sozial-oekologischen-wohn-und-bauwende/

54 WBGU – Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen (2019): Unsere gemeinsame digitale Zukunft. Berlin: WBGU. https://www.wbgu.de/de/publikationen/publikation/unsere-gemeinsame-digitale-zukunft

55 Deutsche Rohstoffagentur – DERA (2021): Rohstoffe für Zukunftstechnologien 2021. Berlin https://www.deutsche-rohstoffagentur.de/DE/Gemeinsames/Produkte/Downloads while most of the raw materials are mined in the 'global south', where working conditions are often inhumane. In addition, there are reports of massive destruction of nature, water consumption and pollution, land grabbing and forced resettlement of local communities. The wealth generated by the profits from the sale of raw materials usually only marginally benefits the country of origin itself.[56]

The demand for primary raw materials for Industry 4.0 applications is exacerbated by the fact that the recycling rate for digital products is significantly lower than in other sectors, as recycling is very extensive due to the large number of elements used, which are only embedded in small concentrations. For this reason, only 35 % of the raw materials used in digital hardware are recycled.[57] This might be higher than for other types of waste, but the consequences of untreated e-waste are far more devastating. For example, while e-waste accounts for only 2 per cent of waste streams, it is responsible for 70 per cent of the hazardous waste components that end up in landfills. It also contains valuable resources that are rapidly becoming scarce on Earth.[58]

At the same time, due to accelerated innovation cycles, many devices – especially digital hardware products such as smartphones – have a limited technical life, which is further shortened by design features such as non-replaceable batteries and software-related hardware obsolescence.[59] The hardware still works, but updated software or security updates are no longer available for continued use. Similar to clothing, there is a trend towards 'fast fashion' for such products. This implies that fully functioning devices are replaced with the latest versions at short intervals. This trend is driven by business models in which user contracts include the replacement of hardware every one or two years.

In Germany, more than 20 kilograms of e-waste are produced per capita each year[60], but only about 10 kilograms are collected per person and year.[61] One reason for this is that small appliances in particular are not properly disposed of, or are disposed of incorrectly, for example in household waste. According to Deutsche Umwelthilfe, an estimated 400,000 tonnes of e-waste is illegally exported from Germany alone every year: The majority of this waste ends up in the Global South, where no infrastructure exists for adequate recycling or refurbishment. Instead, this form of disposal leads to the devastation of landscapes, disease and promotes inhumane working conditions.[62]

The narrative of digitalisation as an opportunity to solve the resource crisis is based in particular on the possibilities of de-materialisation and increased efficiency: these are supposed to ensure that fewer products are manufactured as for example smartphones combine more and more functions that previously required several devices. Furthermore, digital platforms open up – at least in theory – the potential for a "sharing economy" and the principle of "use rather than own".

Nevertheless, the DERA analysis shows that further increase in the development and production of future technologies, and therefore demand for raw materials, has to be expected. One reason for this is rebound effects, where the savings achieved are outweighed through increased consumption and additional applications.

For a sustainable and environmentally friendly future of digitalisation, BUND advocates the principle of "digital sufficiency"[63] as a political strategy. Digital sufficiency is based on the guiding principle of "as much digitalisation as necessary and as little as possible" and aims to contribute to a socio-ecological transformation of society while minimising negative impacts on people and the environment.

56 AK Rohstoffe (2021): Warum wir dringend eine Rohstoffwende brauchen! 12 Argumente für eine Rohstoffwende. https://ak-rohstoffe.de/rohstoffwende/

57 Sydow, Heinz 2020 – Germanwatch

58 Piek, Martin (2022): So wenig von deinem Elektroschrott wird wirklich verwertet. https://www.quarks.de/umwelt/muell/so-wenig-von-deinem-elektroschrott-wird-wirklich-verwertet/

59 Dies ist die sogenannte funktionale Obsoleszenz. Obsoleszenz bezeichnet die (natürliche oder künstliche) Alterung eines Produkts in deren Folge das Produkt nicht mehr für den gewünschten Zweck eingesetzt werden kann. Bei der funktionalen Obsoleszenz wird das Produkt durch geänderte technische und funktionale Anforderungen unbrauchbar, bspw. weil Schnittstellen von Hard- und Software nicht mehr kompatibel sind oder weil keine neuen Software-Updates angeboten werden. Vgl. https://www.oeko.de/forschung-beratung/themen/konsum-und-unternehmen/fragen-und-antworten-zu-obsoleszenz

60 Forti, V., Balde, C. P., Kuehr, R. and Bel, G. (2020): The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential, (Bonn, Geneva and Rotterdam: United Nations University/United Nations Institute for Training and Research, International Telecommunication Union, and International Solid Waste Association, 2020).

61 Umweltbundesamt (2022): Elektroaltgeräte. https://www.umweltbundesamt.de/themen/abfall-ressourcen/produktverantwortung-in-der-abfallwirtschaft/elektroaltgeraete#elektronikaltgerate-in-deutschland

62 DUH (2018): Illegaler Export von Elektroschrott: Deutsche Umwelthilfe fordert Umsetzung der Rücknahmepflicht durch Handelsunternehmen und mehr Zollkontrollen. Pressemitteilung. https://www.duh.de/presse/pressemitteilungen/pressemitteilung/illegaler-export-von-elektroschrott-deutsche-umwelthilfe-fordert-umsetzung-der-ruecknahmepflicht-dur/

62 Lange, S., Santarius, T., Zahrnt, A. (2019): Von Der Effizienz Zur Digitalen Suffizienz. Warum schlanke Codes und eine reflektierte Nutzung unerlässlich sind. In: Höfner, A.; Frick, V. (Hrsg.): Was Bits und Bäume verbindet – Digitalisierung nachhaltig gestalten, S. 112-114.

63 Lange, S., Santarius, T., Zahrnt, A. (2019): Von Der Effizienz Zur Digitalen Suffizienz. Warum schlanke Codes und eine reflektierte Nutzung unerlässlich sind. In: Höfner, A.; Frick, V. (Hrsg.): Was Bits und Bäume verbindet – Digitalisierung nachhaltig gestalten, S. 112-114.

Factors for desired change:

- Manufacturer-independent right to repair and ban on planned hardware obsolescence for digital devices
- Mandatory provision of updates, whose codes must be published if the manufacturer can no longer guarantee this
- Strong supply chain legislation that obliges manufacturers and raw material suppliers to meet environmental and human rights standards throughout the entire raw material supply chain.
- Highest possible recyclability of all processed raw materials in new products, with the lowest possible input of primary raw materials ('design for recycling').
- A clear, critical policy strategy for using digitalisation in terms of digital sufficiency
- Binding EU-wide collection rates and increased recycling rates for used electrical and electronic equipment by extending producer responsibility.
- Stricter and more consistent controls to prevent illegal disposal of e-waste
- Mandatory technology assessment of digital innovations with a focus on the environmental impact and the global implications of production, in particular the social effects of supply chains.

3.5. Chemistry

The global chemical industry currently doubles its production about every ten to twelve years. In addition, virtually all basic chemicals and plastics are currently produced from fossil raw materials, mainly oil and natural gas. However, various scenarios already show how the chemical and plastics industries can continue to grow while increasingly using other sources of raw materials.

The nova Institute scenario for the chemical industry (2021) assumes that global plastics production will triple by 2050.[64] Meys et al. (2021) even expect production to increase by a factor of 3.7.[65] Unfortunately, none of these studies consider the limits of the available quantities of the relevant raw material sources.

The large amounts of carbon that according to these studies can be recovered from mechanical, "chemical recycling", "CO_2 recycling" or biomass are unrealistic. The expansion of biomass production is limited primarily by the scarcity of land, but also by the eutrophication and acidification of soils caused by agro-industry, with direct negative consequences for ecosystems. The biomass that is sustainably available worldwide can replace less than 10 per cent of the current consumption of fossil resources.[66] Moreover, even biomass production requires the use of additional quantities of fossil resources (for fertiliser production, processing, etc.). Furthermore, the desire for increased production of plant biomass could encourage the use of (new) genetic engineering, often presented as an important plant breeding technique[67], but which in itself is associated with environmental risks.[68]

Nevertheless, high-quality mechanical recycling of plastics remains complex and is not possible without process losses. The highest costs are caused by necessary collection and transport activities. With regard to collection volumes, the authors of the study refer to a different study, which itself concludes that more than 80 per cent of plastic waste will still be lost in 2040.[69] With regard to "chemical recycling" or "CO_2 recycling", the high energy consumption of these processes will limit their expansion; additionally, these technologies still lack the necessary market maturity and practicable logistics.

If these scenarios are likely to occur, by 2050 the industry would only be allowed to use all its available energy for the production of plastics. However the global chemical industry produces much more: pesticides, industrial chemicals, chemicals in products, antibiotics

64 nova-Institut (2021): World Plastic Production and Carbon Feedstock – in 2018 and Scenario for 2050 (in million tonnes). https://renewable-carbon.eu/publications/product/world-plastic-production-and-carbon-feedstock-in-2018-and-scenario-for-2050-graphic/

65 Meys, R., Kätelhön, A., Bachmann, M., Winter, B., Zibunas, C., Suh, S., Bardow, A. (2021): Achieving net-zero greenhouse gas emission plastics by a circular carbon economy. Science 374, 71-76. https://doi.org/10.1126/science.abg9853

66 Schindler, J., Zittel, W. (2006). Peak oil: Der Strukturbruch konventioneller Energieerzeugung. Natur & Kultur 7(1): 23-41. Spangenberg, J. H., Settele, J. (2009). Neither Climate Protection nor Energy Security: Biofuels for Biofools? Journal of International Relations/ Uluslararası İlişkiler 20(5): 89-108.

67 BMBF (2021): Die Werkzeuge der Bioökonomie. Innovative Technologien für die biobasierte Wirtschaft. Berlin. https://www.bmbf.de/SharedDocs/Publikationen/de/bmbf/7/31659_Die_Werkzeuge_der_Biooekonomie.pdf?__blob=publicationFile&v=4

68 BUND (2022): Ökologische Risiken der neuen Gentechnikverfahren. https://www.bund.net/service/publikationen/detail/publication/oekologische-risiken-der-neuen-gentechnikverfahren/

69 Lau, W. W., Shiran, Y., Bailey, R. M., Cook, E., Stuchtey, M. R., Koskella, J., ... & Palardy, J.

and other pharmaceuticals; more than 350,000 chemical substances are in circulation worldwide. Moreover, the "planetary boundary" of "new substances" is already exceeded by the chemicals and plastics currently produced and in the environment, or more precisely, by their quantities and composition.

It is evident that the scenarios of continued growth in the production of chemicals and plastics described above is incompatible with the identified planetary limits. The production of chemicals and plastics and the associated use of resources has to be significantly reduced and limits have to be set for chemical production.

For chemicals to be part of a circular economy at all, they must be produced according to the 'safe by design' principle[70]. As negotiations on an international plastics convention have only just begun and will take years to conclude, the German government and the EU must take the lead.

The transformation of the industry towards an energy-saving economy based on secondary raw materials is urgently needed. In the long term, there will only be a limited amount of carbon available either from biomass or other processes such as CCU (capture, transport and use).

The position paper "Nachhaltige Stoffpolitik zum Schutz von Klima und Biodiversität" (Sustainable Substances Policy for the Protection of Climate and Biodiversity)[71] provides a detailed discussion of these issues.

[70] As defined by the OECD, Safe by Design refers to the identification of risks and uncertainties to people and the environment at an early stage of the innovation process in order to minimise uncertainty, potential hazards and/or exposure. The approach addresses the safety of the material/product and related processes throughout its life cycle: from the research and development (R&D) phase, through production and use, to recycling and disposal. https://images.chemycal.com/Media/Files/env-jm-mono(2020)36-REV1.pdf

[71] https://www.bund.net/service/publikationen/detail/publication/nachhaltige-stoffpolitik-zum-schutz-von-klima-und-biodiversitaet/

4. Status quo: Political and legal framework

More ambitious measures are needed to fundamentally and permanently change resource use and ensure that it remains within planetary boundaries. Existing regulations are insufficient. These regulations are either not primarily designed to protect resources, for example the WTO law and the REACH Regulation (EC) No. 1907/2006, the EU Ecodesign Directive, EU public procurement law (Directive 2014/24EU), the EU Construction Products Regulation (305/201) and the German Federal Mining Act (Bundesberggesetz – BBergG), or they simply do not include any concrete limits for resource use, as for example the German Packaging Ordinance (Verpackungsgesetz), the EU Packaging Waste Directive (2005/20/EC) and the EU Waste Electrical and Electronic Equipment Directive (2012/19/EU). To ensure that the relevant legal framework is truly sustainable, the current regulations at national and EU level need to be examined for weaknesses and opportunities for improvement.

4.1. National approaches

The German Recycling and Waste Management Act (Kreislaufwirtschaftsgesetz – KrWG) has no qualitative or quantitative targets for resource protection, and the overarching goal of prevention has never been operationalised through legislation. This is reflected in the national demand for primary raw materials. As a result, the ratio of newly extracted materials to recycled materials has only been reduced by one percentage point from 89 to 88 percent in the period from 2010 to 2019.

France
The disposal or destruction of edible food is prohibited by the law against food waste ("LOI n° 2016-138 relative à la Lutte contre le gaspillage alimentaire", section 6.3). The French government addresses the disposal of unsold textiles and clothing in its roadmap for the development of France's circular economy by prohibiting these disposal routes.

In its current form, the KrWG mainly regulates the processing and treatment of products after they have become waste.[72]

For more than 20 years, the German government's resource policy has followed the approach of reducing resource use by increasing resource productivity. Even the most recent programmes, ProgRess I, II and III, which were launched with the objective of doubling resource productivity between 1994 and 2020, failed to achieve their target.[73] Furthermore, the single-minded focus on increasing efficiency has not led to an absolute reduction in the use of primary raw materials.[74]

The federal laws and special regulations, as well as the specific programmes and strategies that have a direct or indirect impact on resource protection, appear as a patchwork quilt. Although these specialised regulations may have the advantage that they can lead to targeted steps within the respective sectors, they have resulted in a fragmented and contradictory resource protection law that will not achieve the primary target of reducing resource use. Three alternatives can be identified for the appropriate adaptation of the legal framework:

a) *Resource Protection Code:* In simple terms, this would be the consolidation of all resource protection regulations into a single code. Although this would be a highly symbolic measure, it would be very costly and politically difficult to implement (e.g. Environmental Code).

b) *Revision of sectoral legislation:* The existing patchwork could be modified within the sectoral regulations. However, even if partially targeted regulations were introduced, the fragmented legal

72 The regulations on prevention that were intended at the time of the introduction of the KrWG have never been implemented in current law.

73 The conclusion is based on the assumption of a continuation of the observed trend in previous years. Current official figures are not available. (Quelle: https://www.umweltbundesamt.de/daten/ressourcen-abfall/rohstoffe-alsressource/rohstoffproduktivitaet#entwicklung-der-rohstoffproduktivitat). It is questionable how seriously the target is intended to be achieved, given that there has been no assessment in the target year.

74 Why this is the case and more on the criticism of GDP as a measure in chapter 6 or in BUND background paper. "Ressourcenschutz ist mehr als Rohstoffeffizienz" https://www.bund.net/fileadmin/user_upload_bund/publikationen/ressourcen_und_technik/ressourcen_ressourcenschutz_hintergrund.pdf

Sweden

A similar approach has been taken by Sweden and eight other EU countries, which have introduced a reduced tax rate of between 5 and 13.5 per cent for minor repairs. Sweden has also introduced tax credits for the cost of repairing electrical appliances.

framework would remain. Finally, it is unclear whether the legislator has a common understanding of resource protection in the different sectoral laws. As a result, this approach poses the problem of inconsistencies and a lack of systematic regulation.

c) *A "framework law" on resource protection:* Similar to climate protection, a framework law is relatively compact. It offers the possibility to focus on essential aspects of resource protection. A framework law would regulate the central issues of resource protection, but leaves it to the various sectors to develop sector-specific technical regulations or to adapt existing regulations. This is easier to implement and has both symbolic impact and political effectiveness. This intermediate course leads to a central but stringent framework law that describes the tasks, principles and objectives of resource protection, but leaves the sector-specific implementation of these requirements to planning, environmental and economic law.

A study by the Federal Environment Agency (UBA) shows how the German legislation could significantly improve the legal framework for resource protection without major structural changes to the legal system. The research project "Legal Instruments for General Resource Protection", which was conducted from 2012 to 2016, examined the integration of an effective resource protection regime in German legislation and defined the framework for a common resource protection law.

Netherlands

In 2016, the Netherlands committed to the implementation of a "complete circular economy" by 2050 as part of its circular economy package. A first stage target is to reduce the use of abiotic primary raw materials – minerals, fossil raw materials and metals – by 50 per cent until 2030. Although ambitious, the plan lacks both a target for biotic raw materials and a critical view of total raw material consumption, which has not changed significantly since 2010. The current version of the circular economy programme focuses too little on sufficiency and too much on the substitution of fossil raw materials with renewable ones. Nevertheless, the planned steps can be benchmarked against the quantifiable target, allowing a more transparent and critical debate and identifying insufficient measures. The Netherlands will also publish a progress report every two years, which can be used to advocate the need for faster and/or more comprehensive action. For the Dutch example, see Langsdorf; Duin (2021).

In addition to the design of a framework law on resource protection, this also includes specific proposals for the implementation of resource protection in various areas of legislation.[75]

The proposals developed lead to noticeable improvements in various fields of action, but especially as part of a more comprehensive concept towards the protection of resources.

The core of this proposal is therefore the Resource Protection framework law. It specifies the tasks of resource protection, sets measurable targets (including a reference and achievement year), structures the political fulfilment of these tasks by the Federal Government and the German parliament, and symboli-

[75] *Roßnagel, A; Hentschel, A. (2017): Rechtliche Instrumente des allgemeinen Ressourcenschutzes. UBA Texte 23/2017. Umweltbundesamt, Dessau-Roßlau. https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2017-03-23_texte_23-2017_ressourcenschutzinstrumente.pdf*

cally commits all citizens to a general resource protection obligation.

4.2. European approaches

The political objective of conserving natural resources is embedded in primary European law (Art. 191(1)(3) TEC), but a consistent European resource protection law is still lacking. Since the beginnings of European resource policy.[76] However, all strategy documents have had the goal of decoupling economic growth from resource consumption.[77]

In the first Environmental Action Programmes before the start of the official resource policy in 2005, the main focus was primarily on waste, which is at the same time the resource policy area with the most detailled and binding regulations.[78]

After 2005, the Commission's "Thematic Strategy on the Sustainable Use of Natural Resources"[79], marked the first shift towards resource protection and resource efficiency, but without binding quantitative targets. In 2011, two new resource policy initiatives were presented, the flagship initiative "Resource efficient Europe"[80] and the "Roadmap to a Resource Efficient Europe"[81], in which relatively ambitious plans for a resource-efficient Europe were presented. According to these plans, by 2050 all resources – from raw materials to energy, water, air, land and soil – are supposed to be managed sustainably, biodiversity and ecosystem services are supposed to be protected or restored, and Europe's climate goals are to be met. The "Resource Efficiency Scoreboard Europe"[82] for the implementation of this roadmap represented a significant development in the areas of progress measurement and communication.

In 2015, the EU Commission presented the EU circular economy package[83], consisting of the circular economy action plan and the waste package. Although the Circular Economy Package and the Action Plan considered the entire product life cycle, they generally set rather weak targets, while the business-oriented focus failed to meet the overarching target set by applying the terminology of "circular economy" ("Kreislaufwirtschaft", unfortunately has a different semantic weighting in German). As a result, discussions about overall consumption or resource protection significantly diminished during the era of EU

Austria

In 2022, the promotion of repair services has been extended through a reduction in the VAT rate (e.g. for bicycle repairs). By introducing the new repair bonus, the costs of repairing electrical appliances will be subsidised by 50 per cent up to a maximum amount of 200 euro. With a funding volume of €130 million, household appliances, IT and communication equipment, consumer electronics, cleaning equipment and electronic toys and garden equipment (https://spatial-resilience.institute/) will be eligible for repair. In addition, Austria has adopted a recycling strategy. This is associated with an additional budget of more than 5 billion euros over a period of five years. Based on its population, Germany would have to allocate 50 billion euros for the same purpose.

The key objectives of the strategy are:

- Reduction of resource consumption
  - Domestic Material Consumption (DMC): maximum 14 tonnes per capita per year (2030)
  - Material footprint (MF): maximum 7 tonnes per capita per year (2050)
- Increase resource productivity by 50 percent (2030)
- Increase circularity rate by 18 percent (2030)
- Reduce private household consumption by 10 per cent (2030)

A first progress report on the implementation of the strategy will be published at the end of 2023.

[76] Vgl. Sanden, Joachim (2015): Rechtsgutachten. Aktuelle Analyse des europäischen Ressourcenschutzrechts. Texte 84/2015. Dessau-Roßlau: Umweltbundesamt.

[77] Vgl. Langsdorf, Susanne (2021): Ressourcenschonungspolitik in der EU. Eine Zusammenschau politischer Strategiepapiere von den Anfängen bis heute. Ecologic Institut, Berlin. https://www.ecologic.eu/sites/default/files/publication/2021/3554-Langsdorf-Ressourcenschonung-in-der-EU-Bericht.pdfWhy this project is set to fail, find out in: Parrique T., Barth J., Briens F., C. Kerschner, Kraus-Polk A., Kuokkanen A., Spangenberg J.H. (2019): Decoupling debunked: Evidence and arguments against green growth as a sole strategy for sustainability. European Environmental Bureau. https://eeb.org/library/decoupling-debunked/.

[78] Article 1 of the Waste Framework Directive of 2008 (currently in force as revised in 2018) states that the objective of the Directive is to "reduce the overall impacts of resource use and improve the efficiency of resource use". The Waste Framework Directive also provides for the waste hierarchy. The hierarchy of waste prevention and management is as follows: a) prevention, b) preparation for reuse, c) recycling, d) other recovery, e.g. energy recovery, e) disposal.

[79] Europäische Kommission (2005): Mitteilung der Kommission an den Rat, das Europäische Parlament, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Thematische Strategie für eine nachhaltige Nutzung natürlicher Ressourcen. KOM(2005)670, Brüssel.

[80] Europäische Kommission (2011): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Ressourcenschonendes Europa – eine Leitinitiative innerhalb der Strategie Europa 2020, KOM(2011) 21, Brüssel.

[81] Europäische Kommission (2011): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Fahrplan für ein ressourcenschonendes Europa, KOM(2011) 571, Brüssel.

[82] Europäische Kommission (2011): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Fahrplan für ein ressourcenschonendes Europa, KOM(2011) 571, Brüssel.

[83] Europäische Kommission (2015): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Den Kreislauf schließen – Ein Aktionsplan der EU für die Kreislaufwirtschaft, COM(2015) 614 final, Brüssel.

Commission President Jean-Claude Juncker. At least the perspective changed: from waste to a more sustainable, i.e. resource-conscious, design of products.

Product design with a view to improved reparability, durability, upgradeability and recyclability will be encouraged in particular through the Ecodesign Directive. However, the first adjustments to the Ecodesign Directive were only adopted in 2019 and came into force in March 2021.[84]

Finally, the 2015 circular economy action plan identified five priority areas: Plastics, food waste, critical raw materials, construction and demolition waste, as well as biomass and bio-based products. However, most of the measures remained very vague. The circular economy package introduced new recycling targets and requirements for separate collection, guidelines for the methodology for calculating recycling and measures to prevent waste, which were included in the Waste Framework Directive.

A reorientation of European resource policy took place in December 2019 with the "European Green Deal"[85], whose main objective is to achieve EU climate neutrality by 2050. Regarding resource protection and circular economy, the sub-target "mobilisation of industry for a clean and circular economy" is highly relevant. The Green Deal sets a number of concrete measures and targets which have been further specified in the Industrial Strategy[86] and the new Action Plan for a Circular Economy 2020.[87] Overall, these new documents indicate a further shift in focus from the end of the value chain to its beginning. The Industry Strategy for Europe 2020 outlines the Commission's ambition for an ecological and digital transformation.

One of the seven principles identified is 'building a circular economy'. The European Commission confirms that we need to "revolutionise the way we design, produce, use and dispose of items".[88]

The new circular economy action plan is the most important instrument of current European resource protection and circular economy policy and is intended to contribute to the objectives of the Green Deal. The Green Deal calls for the development of a new growth model in which resource use remains within planetary limits. Conventional economic growth models, which promote pure economic growth, are not compatible with the objective of reducing resource use.[89]

In addition to these ambitious but vague targets, the Action Plan's only specific target is rather modest: The proportion of materials used that are actually recycled is to be doubled by 2030. More ambitious quantitative targets, such as a significant reduction or even halving of the EU's material footprint, which had been included in the drafts of the Action Plan, were removed in the last stages of voting.[90]

One of the more practical key areas of the action plan adopted is the product policy, which includes a package of specific proposals, such as regulations on reparability and an increase in the recycled content of products. The Commission has announced a legislative initiative for sustainable product policy.

In summary, none of the EU documents adopted so far has set a specific quantitative target for reducing resource use. However, a measurable and verifiable target would be essential for a real change in resource use. In addition, the potential for resource protection that is already present in many existing EU regulations is not applied to its full extent.

84 Europäische Union (2019): Verordnung (EU) 2019/2021 der Kommission vom 1. Oktober 2019 zur Festlegung von Ökodesign-Anforderungen an elektronische Displays gemäß der Richtlinie 2009/125/EG des Europäischen Parlaments und des Rates, zur Änderung der Verordnung (EG) Nr. 1275/2008 der Kommission und zur Aufhebung der Verordnung (EG) Nr. 642/2009 der Kommission (Text von Bedeutung für den EWR.) C/2019/2122., OJ L 315, 5.12.2019, p. 241–266.

85 Europäische Kommission (2019): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Der europäische Grüne Deal, COM(2019) 640 final, Brüssel.

86 Europäische Kommission (2020): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Eine neue Industriestrategie für Europa. COM(2020) 102 final, Brüssel.

87 Europäische Kommission (2020): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Ein neuer Aktionsplan für die Kreislaufwirtschaft. Für ein saubereres und wettbewerbsfähigeres Europa, COM(2020) 98 final, Brüssel.

88 Europäische Kommission (2020a): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Eine neue Industriestrategie für Europa. COM(2020) 102 final, Brüssel, S.11.

89 Parrique T., Barth J., Briens F., C. Kerschner, Kraus-Polk A., Kuokkanen A., Spangenberg J.H. (2019): Decoupling debunked: Evidence and arguments against green growth as a sole strategy for sustainability. European Environmental Bureau. https://eeb.org/library/decoupling-debunked/ Lehmann, H.; Hinske, C.; de Margerie, V.; Slaveikova Nikolova, A. (Hrsg.) (2022): The impossibilities of the Circular Economy. Separating Aspirations from Reality. Routledge, London.

90 Schneider, Henriette (2020): Europäischer Aktionsplan zur Kreislaufwirtschaft. Deutschland muss während der Ratspräsidentschaft für ambitionierte Umsetzung sorgen. https://www.ressourcenwende.net/blog/europaeischer-aktionsplan-zur-kreislaufwirtschaft/

Supply Chain Act in Germany and Europe

Since raw materials are traded globally and Germany is heavily dependent on imports (especially of metallic raw materials), it is important to consider the entire supply chain of German and European companies. This is the only way to prevent human rights violations and environmental pollution associated with the extraction and processing of raw materials. After long advocacy by NGOs and initiatives, the German Bundestag passed the Supply Chain Due Diligence Act in June 2021. The Supply Chain Due Diligence Act is a success for civil society. But unfortunately it does not yet contribute to the prevention of species extinction and the climate crisis. The law does not provide any integrated protection for the environment and climate. Moreover, it requires only a few German companies to fulfil general due diligence obligations towards their direct suppliers. The problems in the supply chain are often located much further down the supply chain, e.g. in the case of intermediate suppliers. However, these only are required to be inspected in individual cases. Furthermore, victims of human rights violations and environmental damage are unable to claim against German companies for noncompliance with the Supply Chain Due Diligence Act.

A supply chain law is being pushed forward at EU level. After the German Supply Chain Due Diligence Act was passed in 2021, the EU Commission followed with its proposal for an EU Supply Chain Act in February 2022. In December 2022, the member states voted in favour of the introduction of a Europe-wide supply chain law. It will remain to anticipate what the law will finally look like after the consultation process between the Council, the Commission and the European Parliament. Unfortunately, the draft proposal still contains a number of loopholes and needs to be clarified and reinforced before it is adopted, despite the efforts of a strong industry lobby to further undermine the already weak proposals.

An effective EU supply chain law would be a first step towards global justice. Only about 100 companies are responsible for more than 70 per cent of global CO_2 emissions since 1988. A supply chain law will not fundamentally change these conditions. But it can at least ensure that companies review their business practices, reduce their emissions across the entire value chain, and guarantee justice for victims. The EU Supply Chain Act should therefore require companies to comply with clearly defined human rights and environmental due diligence obligations.

5. The limits of circular economy

The fact that the principle of circular economy is a major driver is clearly reflected in the European "Green Deal" and the "Circular Economy Action Plan", as well as in the German government's ongoing efforts to develop a national circular economy strategy. However, it is often neglected that the circular economy has its limitations.[91] A completely closed recycling system is not feasible. For example, the unused tailings from the extraction of primary raw materials cannot be recycled. In addition, every conversion process of materials or energy is associated with dissipative losses.. The deficits of these strategies, in particular their ignorance of the irreversibility of economic processes, result in resource use not being reduced regardless of efforts to achieve circularity. Even if it would be possible to transform the linear economy into a circular economy, a part of the resources would be irretrievably lost due to entropy and dissipation losses.[92] Although it seems feasible to reduce resource consumption per euro of GDP by half in the medium term, as the economy continues to grow, the demand for new primary materials will continue to rise steadily.[93]

It is not surprising that recycling, increasing efficiency and substituting non-renewable resources with renewable ones – which are the most important strategies at present – have not succeeded in reducing resource use.[94] If, in future, the supply of non-renewable materials is primarily or even exclusively based on secondary raw materials, the issue of (re-)usability of materials and the associated loss of materials and energy within recycling systems will take on greater relevance.

While a 100 % circular economy is not physically possible, in addition the approach is restricted in practice by numerous legal, organisational and economic barriers. As a result of combining a substantial part of the costs of resource extraction and waste disposal, the secondary raw materials are not economically competitive with primary raw materials. Furthermore, the primary raw materials in the current system do not have an "intrinsic value"; instead, they are priced at the cost of extraction and refining. In order to solve this problem, various political instruments would be available, ranging from higher disposal and landfill fees to an extraction tax on primary raw materials. Systematising and harmonising the criteria for the status of secondary raw materials and thus removing them from the waste regime, would be an important step towards eliminating the current unequal treatment of secondary raw materials. Finally, the public sector itself can make an important contribution by changing its procurement rules in order to favour the use of secondary raw materials.

91 Vgl. Mederake, Linda (2022): Without a Debate on Sufficiency, a Circular Plastics Economy will Remain an Illusion. Circ.Econ.Sust. https://doi.org/10.1007/s43615-022-00240-3

92 Dissipative losses refer to the loss of energy in a system due to internal friction or other forms of energy conversion. When energy is introduced into a system, part of it is not used and is usually dissipated as heat. https://www.energie-lexikon.info/energieverlust.html

93 Lehmann, H.; Hinske, C.; de Margerie, V.; Slaveikova Nikolova, A. (Hrsg.) (2022): The impossibilities of the Circular Economy. Separating Aspirations from Reality. Routledge, London. This issue is well illustrated in the comic book accompanying the book, available at https://360dialogues.com/360portfolios/ce-impossibilities.

94 Over the last decade, resource productivity gains that reduce consumption have been in balance with consumption-driven growth.

6. The end of waste: Germany needs a sufficiency strategy

We need a drastic overall reduction in the use of resources if we want to stop global warming and the loss of biodiversity, in order to survive as a species and preserve the world for future generations. However, the word "we" does not imply that all people on earth will have to contribute equally. Both at global and national level, income and living standards, and hence resource consumption, are distributed in a socially very unequal way.

The necessary reduction of resource use therefore necessarily must go hand-in-hand with a comprehensive societal and economic transformation. If many people are not informed and involved as actors in this transformation, i.e. if they are not able to participate in democratic decision-making processes, this transformation will either not succeed or will only be possible by using autocratic or dictatorial measures, which BUND strongly opposes.

From BUND's point of view, the transformation towards an absolute reduction in resource use can only be achieved with the help of three complementary strategic approaches: Efficiency, Consistency and Sufficiency.

a) The **sufficiency strategy** poses the question of "enough". It aims to maintain the right measure and promotes the awareness of how to deal with limited resources. However, it is not a question of scarcity and self-sacrifice, but a "less" in terms of production, consumption and use, which often means a "more" in terms of satisfaction of needs and well-being. In this view, the same or even greater benefit for the individual can be achieved by choosing alternative products, alternative forms of use and alternative structures of ownership. The objective is to satisfy people's needs while at the same time achieving a drastic reduction in the amount of production and consumption as well as in the use of energy and resources.

b) The **efficiency strategy** focuses on using resources carefully and for as long as possible, in order to reduce the specific use of resources in relation to the benefit generated. For example, individual products should be manufactured with reduced use of resources. The current strategic focus of the German government is to decouple resource consumption from value creation. However, but as long as value creation only includes monetary values and does not reflect material consumption when setting prices, resource efficiency as an indicator will have no ecological significance.[95] On the one hand, there is no empirical evidence that a sufficient degree of decoupling is possible, while on the other hand there are more than enough references showing that such concepts have failed in the past. Therefore it is not very likely that they will succeed in the future.[96] The savings in resources resulting from efficiency gains are likely to be outweighed by increases in production and consumption or by the accelerating flow of materials. This rebound effect results in a higher absolute resource use even though resource efficiency is higher, which in consequence has to be counteracted by consistency and sufficiency strategies.

c) The **consistency ctrategy** is directed towards the reduction of resources through circular economy, i.e. increased durability and improved repairability of products, multiple use and reuse of second-hand products at other locations, and the recovery of (secondary) raw materials through the highest possible level of recycling. The Consistency Strategy also includes measures to ensure that any substances that are released into the environment can be safely incorporated into biogeological processes.

However, without a successful Sufficiency Strategy, all efforts to achieve greater efficiency and consistency will remain ineffective. The Sufficiency Strategy is therefore the necessary framework for the meaningful implementation of efficiency and consistency strategies.[97]

95 Detailed information on why GDP is an inappropriate measure of resource efficiency can be found in the BUND background paper. "Ressourcenschutz ist mehr als Rohstoffeffizienz". https://www.bund.net/fileadmin/user_upload_bund/publikationen/ressourcen_und_technik/ressourcen_ressourcenschutz_hintergrund.pdf

96 Parrique T., Barth J., Briens F., C. Kerschner, Kraus-Polk A., Kuokkanen A., Spangenberg J.H. (2019): Decoupling debunked: Evidence and arguments against green growth as a sole strategy for sustainability. European Environmental Bureau. https://eeb.org/library/decoupling-debunked/ Lehmann, H.; Hinske, C.; de Margerie, V.; Slaveikova Nikolova, A. (Hrsg.) (2022): The impossibilities of the Circular Economy. Separating Aspirations from Reality. Routledge, London.

97 That sufficiency policy is a key factor for the success of the socio-ecological transformation is now acknowledged by many important sources, bodies and institutions. For example, the Leopoldina (https://www.leopoldina.org/presse-1/pressemitteilungen/pressemitteilung/press/2944/), in IPCC (AR6, Summary for Policymakers, Teil 3) and Target 16 of the Global Biodiversity Framework outlines the objective of sufficiency.

While measures to improve efficiency and consistency are largely undisputed and are usually relatively easy to implement in social and economic terms, increasing acceptance of sufficiency and its societal success will require a growing awareness of the limited availability of resources in all areas, as well as the realisation that material wealth and well-being are not equivalent and the consumption of goods can only satisfy part of people's needs. Combined with well-defined resource protection targets, this societal commitment is a fundamental requirement for a sustainable economy in which value creation and socially fair distribution are measured against a precisely specified resource budget. In other words, a sufficiency strategy guarantees that there is enough for everyone in the future.

7. Resource protection targets for absolute reduction of resource use

7.1. Why we need resource protection targets

No limits have yet been set for the use of resources. Even though it is now widely accepted in the environmental sciences that resource consumption must be drastically reduced, resource protection, unlike climate protection, does not even have target values for reducing resource use.[98] There is a lack of defined and politically binding resource protection targets for the absolute reduction of resource use, at national, European and international level. Similarly, there are no internationally binding treaties that specifically address resource protection. The legally binding 1.5 degree limit in Article 2 of the Paris Agreement is only a indirect obligation to reduce fossil fuel consumption to zero in all areas and to drastically reduce livestock farming; in addition, the Biodiversity Convention is an obligation to stop the loss of biodiversity.[99]

Article 20a of the German Constitution (Grundgesetz) enshrines the protection of future generations in relation to natural resources. Resources are part of the natural basis of life and are therefore included in this guaranteed right to protection. This was also confirmed by the Federal Constitutional Court in its decision on BUND's successful climate lawsuit. These fundamental rights and other legal requirements now also need to be enshrined in EU law. A policy that takes this task seriously has to adopt strong quantifiable targets, to introduce ambitious measures to achieve these targets and to enforce them. It is only on the basis of well-defined targets that for example the German government and the EU Commission will be able to verify the effectiveness of the implemented measures to reduce the use of resources.

Standardised calculation methods for quantitative "per capita consumption" not only enable resource consumption to be compared internationally, they also allow measuring the progress made towards a future-oriented economy with sustainable resource use.

National targets must be based on the national domestic consumption of goods and should not be restricted to national extraction volumes or their direct use. National targets must consider the entire life cycle and resource use of products, regardless of the origin of raw materials (this includes unused extraction, such as the tailings that are moved during the extraction process). In addition, targets must be set on a per capita basis, i.e. the consumption needs to be quantified per person. Such quantified resource protection targets, which must be regularly reviewed, help to ensure that, unlike in the past decades[100], the measures taken do not lead nowhere.

7.2. How resource protection targets should be designed

It is urgent to manage the transition to sustainable resource management. Despite the undoubted difficulties of setting targets, besides a number of valid approaches, there is a constantly evolving data base.

The discussion on the exact scale of resource use reduction required is not new. Already in the early 1990s, Friedrich Schmidt-Bleek argued that the rich industrialised countries would have to reduce their resource use by a factor of 10 (or 90 per cent) within 50 years in order to ensure sustainable and equitable resource use worldwide. In 1996, Ernst Ulrich von Weizsäcker published **"Factor Four. Doubling prosperity – halving resource use",** his report to the Club of Rome calling for a 75 per cent reduction in specific resource use. Both Schmidt-Bleek and Weizsäcker were convinced that a dematerialisation of the economy with the appropriate resource efficiency (or resource productivity) would lead to a drastic reduction in resource consumption.

These publications caused a major impact at the time, and even the environment ministers of the OECD countries publicly declared in 1998: "The ministers agree ... to promote an international policy that

98 BUND has been advocating for the stop of net land use and a reduction of material flows, first by 50% and finally by 90% (factor 10), for more than a quarter of a century.

99 See also chapter 5 or BUND background paper "Ressourcenschutz ist mehr als Rohstoffproduktivität" https://www.bund.net/fileadmin/user_upload_bund/publikationen/ressourcen_und_technik/ressourcen_ressourcenschutz_hintergrund.pdf

100 Ressourcenwende-Netzwerk (2021): Ressourcenschutzziele zur absoluten Reduktion des Ressourcenverbrauchs. Policy Brief. https://www.ressourcenwende.net/publikationen/policy-brief-ressourcenschutzziele-zur-absoluten-reduktion-des-ressourcenverbrauchs/

enables coherence between economic, environmental and social policies by ... innovative proposals such as eco-efficiency, which aims at a significant increase in resource productivity, for example factor 4 and later factor 10".[101]

This was also the starting point for resource efficiency policies worldwide. In Germany, this resulted in the government's first **Resource Efficiency Programme (ProgRess)** in 2012. By then, however, the targets had been substantially weakened, with the result that instead to achieve a reduction in absolute resource consumption by a factor of 10 or 4, all that remained was to increase relative resource productivity by a factor of 2. In addition, this increase in resource productivity is measured in relation to GDP and therefore has no ecological significance whatsoever.[102] 30 years after the first publications on this issue, it is obvious that efforts to increase resource productivity have failed to reduce resource consumption sufficiently. The German government's Resource Efficiency Programme can therefore be considered a failure (see also Section 4.1). The focus of the debate on increasing efficiency has even resulted in losing track of the actual target, the reduction of resource use.

More recent publications have also been published. The **RESCUE study by the Federal Environment Agency** demonstrates that it is possible and necessary to reduce resource consumption to 5.7 tonnes per capita by 2050, i.e. by 70 per cent (compared to 2010). A useful overview of the current discussions on possible resource protection targets is provided by the research of Stefan Bringezu, who defines target corridors for sustainable resource use.[103] A detailed summary of his results is available in a monograph published in 2022.[104] Bringezu proposes two target corridors for 2050: For abiotic resources a reduction to between six and twelve tonnes per person, for biotic resources to two tonnes per person. The German Council for Sustainable Development therefore recommends that "by 2050 (...) the consumption of abiotic primary resources should be reduced to a maximum of six tonnes per person and year".[105] The Council also recommends an interim target of a 50 per cent reduction by 2030 compared with the 2008 baseline. Furthermore, the Council advises a reduction in the consumption of biological primary raw materials to a maximum of 2 tonnes per person and year by 2050.

Germany's total primary material consumption (measured in TMC) was last calculated for the year 2008. At that time it was approx. 45 tonnes per person.[106] Almost four tonnes of these were biotic resources and the remaining were abiotic. The necessary reduction in resource use to a sustainable level of six tonnes per person of abiotic resources and two tonnes per person of biotic resources, as recommended by the German Council for Sustainable Development and advocated by the BUND (Friends of the Earth Germany), would require a reduction of around 85 per cent respectively 45 per cent by 2050. As resource use per capita in Germany has remained virtually unchanged over the last years, but instead has stabilised at a high level[107], the required reduction has practically stayed the same as it was in 2008.

[101] *Factor 10 Institute (2000): Faktor 10 Manifesto. http://www.factor10-institute.org/pages/factor_10_manifesto_d.html*

[102] *BUND Hintergrund "Ressourcenschutz ist mehr als Rohstoffeffizienz" https://www.bund.net/fileadmin/user_upload_bund/publikationen/ressourcen_und_technik/ressourcen_ressourcenschutz_hintergrund.pdf*

[103] *Bringezu, S. (2015): Possible Target Corridor for Sustainable Use of Global Material Resources. Resources 4, no. 1: 25-54. https://doi.org/10.3390/resources4010025.*

[104] *Bringezu, S. (2022): Das Weltbudget. Sichere und faire Ressourcennutzung als globale Überlebensstrategie. Springer Wiesbaden. https://doi.org/10.1007/978-3-658-37774-8.*

[105] *Rat für Nachhaltige Entwicklung (2021): Stellungnahme Zirkuläres Wirtschaften: Hebelwirkung für eine nachhaltige Transformation. Berlin. https://www.nachhaltigkeitsrat.de/wp-content/uploads/2021/10/20211005_RNE_Stellungnahme_zirkulaeres_Wirtschaften.pdf*

[106] *Ohne Erosion. Quelle: Umweltbundesamt (Hrsg) (2013): Aktualisierung von nationalen und internationalen Ressourcenkennzahlen. Texte 07/2013. Dessau-Roßlau. https://www.umweltbundesamt.de/publikationen/aktualisierung-von-nationalen-internationalen*

[107] *Umweltbundesamt (Hrsg.) (2022): Die Nutzung natürlicher Ressourcen. Bericht für Deutschland 2022. Ressourcenbericht für Deutschland 2022. Spezial: Rohstoffnutzung der Zukunft. Dessau-Roßlau. https://www.umweltbundesamt.de/ressourcenbericht2022*

8. Conclusion: What BUND demands

The socio-ecological transformation towards a sustainable and globally compatible lifestyle and economic system that is oriented towards respecting "planetary boundaries" is one of the greatest challenges of the 21st century. Without a reorientation of resource policy in order to significantly reduce the amount of resources used, it will be impossible to achieve the internationally binding climate and biodiversity targets. There is an urgent need to abandon the constantly increasing use of energy and material resources within the framework of an economic system that is harmful to nature and the environment. In the long term, this will only be possible by moving the global economy beyond the economic growth model and by developing new models for prosperity and economic success. In order to initiate this major transformation in the near future, BUND is advocating the following measures:

1. **BUND calls on the Federal Government to launch a legislative initiative for a resource protection law in the form of a framework law, which defines the scope and principles of resource protection without having to rewrite all the existing regulations in the individual sectoral laws into a single resource protection code.**

The principles of resource protection should be specified in a resource protection framework law as applicable requirements for the application of legislation and the interpretation of sectoral legislation. Important principles for such a resource protection framework law can be derived from the following guiding principles: a) the efficient use of natural resources, b) the protection of non-renewable resources, c) the environmental compatibility covering the whole life cycle of a product, d) the social compatibility of resource use. This can be done, for example, by using the preliminary work of the Federal Environment Agency, which has already issued a draft of a framework law in 2012.[108]

2. **BUND calls on the German government to adopt the recommendations of the German Council for Sustainable Development presented in Chapter 7 and to set two specific and binding resource protection targets for this purpose:**
   ❯ By 2050, the consumption of primary abiotic resources is to be reduced to a maximum of six tonnes per person and year (measured in TMC, i.e. including the international resource footprint, for details on the calculation method we refer to the technical annex).[109]
   ❯ By 2050, the consumption of primary biotic resources must be reduced to a maximum of two tonnes per person per year.

In order to achieve these goals, the interim target is to reduce the use of abiotic primary resources per capita and year by at least 50 per cent by 2030 based on the reference year 2008, which means to a maximum of 22 tonnes. For this purpose, a monitoring system has to be established which verifies and measures progress. These monitoring reports have to be published.

In addition to these two overarching measures, further steps, instruments and measures are necessary at various levels. To ensure that all these efforts lead to the desired target, a binding legal framework is essential, i.e. the adoption of a Resource Protection paernt Law and the adoption of overarching resource protection targets.

As an initial step, BUND therefore calls on the German government to ensure that these legally binding amendments on resource protection are included as a central component of the National Strategy for Circular Economy. In the medium term, the circular economy strategy must be transformed into a resource strategy that in particular considers the reduction of resource use (sufficiency).

108 Roßnagel, A; Hentschel, A. (2017): Rechtliche Instrumente des allgemeinen Ressourcenschutzes. UBA Texte 23/2017. Umweltbundesamt, Dessau-Roßlau. https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2017-03-23_texte_23-2017_ressourcenschutzinstrumente.pdf

109 Linn Persson et. al., Stockholm Environment Institute, in "Environmental Science & Technology" 10/2021, https://pubs.acs.org/doi/10.1021/acs.est.1c04158?fig=tgr1&ref=pdf

Technical annex

How resource protection targets should be measured

Quantifying resource use requires a solid data base. The creation of a completely new data base for worldwide measurement would require a significant amount of effort. The research projects that have been initiated so far therefore focus on using existing data and indicators to monitor resource use and derive target values.

Table 1 shows the different indicators:

Indicators for raw material consumption

Type of indicator	Indicators		Accounting principle
Input	DMI	Direct Material Input	DMI = Direct Material Input + Imports
	TMI	Total Material Input	TMI = DMI + disposal of unused domestic extraction
	RMI	Raw Material Input	RMI = DMI + used part of Imports ecological footprint
	TMR	Total Material Requirement	TMR = TMI + Imports ecological footprint
Output	DPO	Domestic Processed Output	DPO = Emissions + Waste + Dissipative use of products
	TDO	Total Domestic Output	TDO = DPO + disposal of unused domestic extraction
Consumption	DMC	Domestic Material Consumption	DMC = DMI – Exports
	RMC	Raw Material Consumption	RMC = RMI – Exporte – used part of Exports ecological footprint
	TMC	Total Material Consumption	TMC = TMR – exports – hidden flows (in economy-wide material flow accounting)

Table 1 Source: BUND Resource protection is more than raw material efficiency 2015

Even at EU level, resource productivity is currently the main indicator used to measure progress in resource protection. It is determined from the ratio of GDP to DMC. First, GDP is not suitable as a basis for calculation, and second, the resource productivity indicator is currently based on domestic material consumption, i.e. domestic material consumption (DMC): Domestic Material Consumption (DMC). DMC excludes unused domestic resource extraction and indirect material flows associated with resource imports (water, land and carbon footprints). More appropriate indicators exist. The Raw Material Consumption (RMC) also includes indirect material flows. Total Material Consumption (TMC) additionally includes unused extraction (e.g. tailings). Since exports do not compensate for the damage caused by imports, the TMC may hide the negative environmental impact of the national economy. For an export nation like Germany, it is therefore important to use not only the TMC, which allows comparison of the environmental impact of national resource use between countries, but also the total material requirement of the German economy, measured in TMR (Total Material Requirement), as a leading indicator. This is essential to provide a realistic picture of the challenges that Germany is facing and the scale of the necessary transformation of our economy.

Increasing resource efficiency or resource productivity is not the same as reducing the use of natural resources, and certainly does not take into account the impact of resource extraction on the environment.[110] A more complete picture would only be obtained if absolute reduction targets for material consumption were set and if both TMC and TMR were covered by an established monitoring system.

The many existing robust indicators and a corresponding data base[111] must be consistently updated and published in the future.

110 *View BUND background paper "Ressourcenschutz ist mehr als Rohstoffeffizienz" https://www.bund.net/fileadmin/user_upload_bund/publikationen/ressourcen_und_technik/ressourcen_ressourcenschutz_hintergrund.pdf*

111 *Lutter, S.; Kreimel, J.; Giljum, S.; Dittrich, M.; Limberger,S.; Ewers, B.; Schoer, K.; Manstein, C. (2022): Die Nutzung natürlicher Ressourcen. Bericht für Deutschland 2022. Umweltbundesamt, Dessau-Roßlau. https://www.umweltbundesamt.de/ressourcenbericht2022*

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