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A Solution Named Dematerialization System Policies

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The dogmas of the quiet past are inadequate to the stormy present. The occasion is piled high with difficulty, and we must rise with the occasion. As our case is new, so we must think anew, and act anew. We must disenthrall ourselves, and then we shall save our country.

Lincoln's Second Annual Message to Congress, December 1, 1862

In brief

Sustainable economic conditions cannot be reached without increasing the resource productivity of the industrialized countries dramatically. By 2050, the world-wide average per capita consumption shall not exceed 8 tons of material per year. System policies need be developed and applied to ascertain success.

KEY CONCEPTS

1. **The existing economic system de-stabilizes the ecosystem services that are crucial for the survival of humans on earth, and cannot be replaced by technology.**

2. **The *physical root cause* imperiling the eco-system services is the enormous consumption of natural resources (material, water, and land surface) for creating material welfare. The *economic root cause* is the near zero price for using nature.**

3. **Limited physical resources on earth, population growth and the need to protect eco-system services necessitate a substantial increase in resource productivity.**

4. **The human economy must be constrained to function *within* the limits of the environment and its resources and in such a way that it works with the grain of, rather than against, natural laws and processes (Ekins).**

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5. First estimates indicate that capping the yearly consumption of natural material resources at close to 6 or 7 tons *per capita* seems unavoidable. This implies a tenfold dematerialization on average for the economy of traditionally industrialized countries.

Ecosystem Services

Human economies are subject to the laws of thermodynamics. On a finite planet, there clearly are limits to the amount of matter that can be mobilized by an economy. Energy is required for its mobilization, for its technical conversion into goods as well as their use and disposal. There are limits that can be accommodated by the biosphere before its eco-system functions and services are affected and begin to deteriorate [2].

Ecosystem services include the availability of liquid fresh water and unpolluted air; of a range of elements, minerals, and metals; of a high level of biodiversity; of edible plants and animals; of productive seeds, sperms, and soil; of a moderate temperature range on the surface of the earth; and of the protection against radiation from outer space. Without ecosystem services, humankind cannot survive.

Ecosystem services cannot be generated by technology on any noticeable scale. Services of nature are indivisible and cost-free available to all humans around the globe. The consequences of their deterioration will be born by all people, irrespective who is responsible for their loss. If they could be traded on the market, ecosystem services would carry an infinitely high price. They are vulnerable to human economic activities.

The *physical root cause* for these changes is the extirpative use of natural resources in the technosphere. Their *economic root cause* is the near zero price for using nature.

Already today, consequences of the excessive use of resources can be observed, e.g. massive soil erosion, water shortages, desertification, loss of species, and climatic changes, as well as increasing catastrophic events like hurricanes and floods. It is obvious that the ecological risk threshold has already been passed. James Hansen (NASA) has postulated that by passing 350 ppm (parts per million) CO_2 in the atmosphere *"a planet similar to the one on which civilization developed"* would no longer exist.

We have almost reached 350 ppm. The growing concentration of CO_2 is largely due to the oxidation of carbonaceous material flows for generating energy. However, not all man-made CO_2 emissions stem from energy

[2] P. Ekins et. al. “A Proposal for Global Resource Policy”, submitted to “Environmental Science and Policy” contact bernd.meyer@uni-osnabrueck.de

generation (e.g. some come from huge subterranean burning of coal seams), and CO_2 emissions generate environmental problems other than climate change. The flow of carbonaceous material through society is but one of the important material flows with various chemical compositions and environmental consequences.

This, of course, is no reason to relax the efforts for coming to grips with the climate issue. But it reminds us that the exclusive solution of one symptom of a systemic problem can delay, increase the costs of, and even prevent the solution of others.

Eliminating the emission of climate changing agents from the technosphere does not suffice to yield a sustainable economy.

The more humans interfere with the natural ecosphere at billions of different locations every day, the more intensive and frequently humans mobilize and extract natural materials from their natural location, the more natural surfaces are denatured or sealed, the more the customary functions and services of the eco-system will weaken, change, and disappear. The more material is mobilized and extracted for feeding the industrial metabolism, the larger will be the discharge of matter from the technosphere, each with its own additional impacts on the environment.

IMPORTANT ACTIONS REQUIRED

Minimize mobilization and use natural resources

Minimize the use and release of eco-toxic substances

System-policies

Traditional policies have *not* been able to prevent the life-threatening deterioration of the eco-system services. Neither have they been able to avoid the near collapse of the banking system. They are *in principle not* pre-cautionary because they are based on reacting to developments *after* they were recognized to be deleterious. Traditional policies tend to prevent, delay and increase the cost of solving problems that are *not* in the limelight of public attention. Traditional policies have thus given cause to enormous repair costs that can eventually far exceed the costs of changing course (Stern Report). Traditional policies are *not* capable of ascertaining sustainable conditions. Business as usual threatens the very survival of humans on earth. Nobody knows, how close we have already come to this.

System-Policies must become the norm because policies seeking to solve individual environmental, societal, economic, and institutional problems one at a time, without

taking inter-dependencies among them into account, cannot protect the environment nor can it lead to a sustained human economy.

Future-oriented system-policies shall no longer focus preferentially – leave alone exclusively - on the solution of individual symptoms stemming from systemic problems. System policies are as essential for measures designed to protect the environment, as they are needed when attempting to seek improvements in pursuing social, economic and institutional improvements.

For instance, calling for "growth" without simultaneous dematerialization of goods and services, increases the environmental crisis. It is doubtful, whether taxing profits from financial transactions will prevent the financial sector from rocking the world economy again by frivolous behavior of bank officials. Attempting to improve the employment situation by stimulating consumption has negative impacts on the stability of the ecosphere because of the commensurate increased consumption of natural resources and energy. Subsidizing the sale of Millions of new cars with billions of euros under condition of forcing the destruction of millions of tons of natural resource investments in existing vehicles is not only ecologically counterproductive, it is as well likely the wrong measure for economic reasons, not to speak of the fact that it prevents urgently needed investments in educational facilities.

System Policies aim to improve happiness, welfare and wellbeing of people by optimizing the efficiency and precautionary nature of measures through eliminating *root causes* of harmful developments, rather than separately repairing their symptoms, which regularly provokes the risk of delaying, increasing the costs of, and even preventing the solution of others. System policies reduce the risks associated with taking actions.

Physical root causes for *endangering eco-systemic services and functions* are the excessive mobilization and use of natural resources (material, water, and land use). The *economic* root cause for the loss of ecosystem services is the near zero cost for using nature.

Root causes for *economic instabilities* include: Wrong price architecture for goods and services; low productivity of natural resources; perverse subsidies; short term planning, and excessive profit taking.

System policies take into account that dematerialization is *not* the only pre-requisite for approaching *ecological* sustainability. Excessive use of water and land are others, as well as introducing eco-toxic substances into nature.

System policies focusing exclusively on ecologically harmful developments cannot lead to sustainability either, because happiness and wellbeing of people also depend on other factors. For instance, Denial of human rights can be the *root cause* for social instability. These rights include: Access to healthy food, water and other natural resources; dignity; justice; gainful employment; health care and education; liberty; security; freedom of speech; and fair distribution of wealth and income (not necessarily in this order).

IMPORTANT ACTIONS REQUIRED

Establish centrally placed "System Policy Units" in government, administration, and industry. Their principal task is to ascertain that each envisioned action is consistent with minimizing overall risks.

Establish a publicly accessible institution that generates, collects, verifies, reviews, and analyzes data and information related to the mobilization and use of natural resources; an institution that supports training and education, eco-design, and the work of "System Policy" and other decision making units. It reports regularly on the resource intensity of GDP, and the performance of important sectors of the economy, employing the indicators mentioned below.

Decoupling Growth from using Nature

The following inter-related areas will be considered here: Targets, Indicators, Technology, and suitable economic conditions for change.

Targets

As all technologies requires the use of natural resources, the following question must be answered: How much dematerialization may be enough to reach steady co-evolution of the environment and the human economy?

There is no possibility known to me for rigorously identifying and quantifying the sum total of impacts of one non-linear complex parasitic system (the economy) upon another that is the host (the ecosphere). Therefore, the following path of reasoning was chosen to estimate a limit beyond which the loss of eco-system services may become critical.

Considering that the global resource use before the time when large-scale environmental insults were observed was about ½ of the that in the early 90ies of last century, considering further that some 20% of the world population consumed about 80% of the natural material at that time, and taking into account that equity demands equal access to natural resources by all people, and finally considering also that the world population still grows, Schmidt-Bleek suggested in 1992 a tenfold dematerialization target on average for western economies [3] [4], a proposal which was endorsed by the highly acclaimed International Factor 10 Club in 1994 [5] .

This concept has since been met with considerable international recognition, both by business and industry, and on government level [6]. The target entered the political agenda – with a first highlight at the Earth Summit +5 (New York, June 1997), where an EU initiative was agreed to on eco-efficiency in industrialized countries: "to consider setting a target of achieving a tenfold improvement in productivity in the long term with a possible four-fold increase in the next two or three decades." UNEP, which also recognizes the consumption of resources to be a key problem, addresses a tenfold reduction target in resource consumption in its report "Global Environment Outlook 2000": "A tenfold reduction in resource consumption in the industrialized countries is a necessary long-term target if adequate resources are to be released for the needs of developing countries."

Today, the yearly *global per capita* material mobilization amounts to over 15 tons (without considering water and plowed soil), suggesting that 6-8 yearly tons *per capita* may well be close to a sustainable consumption limit, including the use of energy carriers. Given the large-scale adjustments necessary, such a target may not be reachable before the middle of the 21st century.

It would seem obvious that the proposed target must be put to serious scientific scrutiny as regards the types of materials and the quantities to be reduced within which period of time, in order to optimize specific actions while minimizing disturbance of the economy. In addition, realistic targets for water consumption and for maximum land use must also be developed with due speed.

When looking at the actual speed of environmental deterioration, there is every reason to believe that increasing resource productivity as fast as possible is urgent, in particular for dematerialized energy generation.

A tenfold overall dematerialization of the economy will by itself yield a substantial reduction in energy demand, perhaps some 30% or more. This estimate, too, deserves detailed studies, because a strategy of general dematerialization may be the most efficient and least costly route for keeping the global warming to within 2° C.

According to a study by A. D. Little and others, reducing the costs for resources by 20% on average would not affect the output of SME's in

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[3] Summarized in F. Schmidt-Bleek, "Wieviel Umwelt braucht der Mensch? MIPS, das Mass fuer oekologischen Wirtschaften", Birkhaeuser, 1993 (English "The Fossil Makers" can be downloaded from www.factor10-institute.org)

[4] L. R. Brown, "PlAN B 4.0, Mobilizing To Save Civilization", New York, 2009

[5] See "Factor 10 Declarations and Recommendations" 1994 – 1997 by the International Factor 10 Club, www.factor10-institute,org. The Club is formed by eminent politicians, scientists and businessmen.

[6] E.g. Business Council for Sustainable Development. The Austrian government introduced a factor ten goal in its 1995 environmental program, the Japanese Government decided in 2001 to make factor 10 part of the strategic national planning.

Germany, amounting to potential savings of more than 150 Billion Euros per annum [7].

Potential added benefits of radically dematerializing the economy could be: Arresting climate change; reducing the loss of forests, species and soil; reducing dependence on resource-rich countries; avoid conflicts resulting from regional scarcity of water, land, and other resources; and lessen the probability of ecological surprises in the future.

Apart from ecological concerns related to the consequences of utilizing natural resources, *Globalizing the western way of life* is *not* possible because it would require the availability of more than two planets earth as resource basis. In spite of this there is little evidence that governments or the private sector are systematically preparing for overcoming pervasive resource scarcities. The reader may also recall that traditional ways of securing supplies of increasingly scarce raw materials is to apply bigger machinery and more energy for mobilizing materials and their extraction - not exactly what one would advice for approaching ecological sustainability.

IMPORTANT ACTIONS REQUIRED

Set targets for the medium and long-term *per capita* mobilization and use of natural resources (material, water, land use); e. g. a 6-8 ton limit of yearly material use per capita by 2050

Promulgate a comprehensive law that regulates the mobilization and use of natural resources (material, water, and land use)

Repeal legal requirements and privileges, standards and norms that demand or encourage resource consumption

Eliminate perverse subsidies

In purchasing procedures, give preference to goods, infrastructures, and services with high resource productivity and longevity

Measuring the Decoupling of Growth from the Use of Nature

Key-indicators must be available for approaching desirable social, economic and institutional goals within the guardrails of stable ecological conditions.

The metrics for relating the ecological basis to the human economy are kilograms (of matter) and square meters (of land) rather than euros or dollars. Much confusion has been generated in the past in discussions about whether or

[7] H. Fischer et. al., “Wachstum und Beschäftigungsimpulse rentabler Materialeinsparungen”, Wirtschaftsdienst, 4, April 2004. Das „Factor 10 Innovation Network“ has made similar observations in several hundred companies.

not there are limits to economic growth by the failure to distinguish clearly between these metrics and specify which is being considered [8].

Indicators for measuring progress in decoupling the use of nature for generating welfare - and for comparing the performance of producers and consumers in this quest – relate the quantity of natural resources (materials, water, and land use) consumed from cradle to cradle in order to produce a unit of the desired solution (output in terms of service, value or utility).

Decoupling indicators should be based on characteristics that are common to *all* processes, goods and services. Their use must always yield directionally safe answers.

On the economic micro-level such units are MIPS for cradle to cradle Material Input [in kg] Pro unit Service (per unit value or utility) obtained; WIPS for the use of Water [in kg]; and FIPS [9] for the use of land [measured in m^2] [10].

F should be further detailed by considering the degree of de-naturalizing the land taken from nature. For instance, when land is plowed for crop production as opposed to being sealed for construction purposes.

On meso- and macro-levels of the economy, indicators such as yearly Total Material Consumption (TMC), or yearly Total Material Flow (TMF) are applied to economic units [11].

Technology

The efforts devoted by manufacturers and consumers to eco-innovation depend on the recompense they can expect on the market.

Today, less than 5 % on average of the material resources taken from nature end up in products. The rest becomes waste on the way. Some 30 tons of nature is used to create one ton of car – without counting water consumption -, and for many industrial goods the ratio is similar. Information and Communication Technology [ICT] is ten times more resource consuming on average. The costs to nature for one bank order per internet is equal to that of producing four aluminum cans for beer [12].

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[8] P. Ekins et. al. “A Proposal for Global Resource Policy”, submitted to “Environmental Science and Policy” contact bernd.meyer@uni-osnabrueck.de

[9] “F” stands for “Fläche”, the German word for area

[10] F. Schmidt-Bleek: “Earth”, Haus Publishers, London 2008

[11] S. Bringezu,:”Erdlandung”, Hirzel, 2004

[12] F. Schmidt-Bleek et. al.,: “Der Oekologische Rucksack”, Hirzel, 2004

Decoupling economic growth from the use of nature is the central task of advanced technology. A new industrial revolution is due - the 6th "Kondratieff wave"- by creating a whole new high-tech world by dematerializing all processes, products, installations, structures and services to the highest degree possible.

The EU definition of eco-innovation is as follows:

> **Eco-innovation** ***means the creation of novel and competitively priced goods, processes, systems, services, and procedures that can satisfy human needs and bring quality of life to all people with a life-cycle-wide minimal use of natural resources (material including energy carriers, and surface area) per unit output, and a minimal release of toxic substances.*** **(Reid, Alasdair, Miedzinski, Michal (2008), EUROPE INNOVA, Final Report for the EU Sectoral Innovation Watch Panel on Eco-Innovation, www.europe-innova.org).**

Practical experience in industry has shown that two- to fourfold dematerialization can often be achieved with state of the art technology and with investments that can be retired within a few years [13]. Dematerializing *existing* products and prolonging their useful lives are usually the first steps.

The biggest gains in saving resources are reachable through taking a systems' approach, focusing on meeting the needs of people rather than on improving existing technology. For instance, Stefan Wrage has re-invented the use of wind for propelling cargo ships over the oceans by means of "SkySails" [14]. Through the use of a (now available) special enzymes, washing temperatures for textiles can be lowered to room temperature, and developing self-cleaning surfaces (micro-technology, lotus effects) can eliminate some cleaning needs altogether, saving billions of tons of water, large quantities of detergents and energy worldwide. Hubert Rhomberg has designed a 25 floor wooden building, easy and fast to erect without waste, and with complete freedom to sub-divide and re-devide each floor according to needs (www. Rhombergbau.at).

IMPORTANT ACTIONS REQUIRED
Focus on fulfilling human dreams and needs, rather than on "greening" existing technical solutions
When designing advanced food stuff, goods, processes, services, and infrastructures, minimize Rucksacks, MIPS, WIPS, and FIPS - while maintaining/improving current western standard of living

13 F. Schmidt-Bleek et. al, "Ökodesign", Austrian Chamber of Commerce, WIFI 303, 1998; F. Schmidt-Bleek, et. al. "Der ökologische Rucksack", Hirzel, 2004, M. Lettenmeier et al." The 7 Steps of Eco-Design", Wuppertal Institut, 2009, ontact Christa.Liedtke@wupperinst.org.

14 "Turn wind into profit", www.skysails.de

Dematerialize dramatically the generation of energy, its storage, transport, and its application Maximize continuous eco-innovation

Achieving a Suitable Economic Framework

Whether or not economic growth in financial terms has a deleterious effect on the environment, depends on the extent to which it is accompanied by growth in energy use and material throughput. Historically, growth in material and energy use have tended to be correlated with economic growth in financial terms, but there is no imperative why this should be so, and it is possible for this link to be broken by technology, once encouraged by public policy [15], [16].

The impacts of the human economy on the eco-system services can be understood as the externalities caused by the economy on the carrier system earth. This argues for a strong conception of sustainability, whereby the economy respects and adapts to ecological imperatives, rather than seeking to substitute manufactured for natural capital where the former fails to deliver the full range of functions and services of the latter.

Most importantly, the human economy must be constrained to function *within* the limits of the environment and its resources and in such a way that it works with the grain of, rather than against, natural laws and processes [17].

Emissions will fall as policies reduce extractions, but there is no guarantee that reducing emissions will reduce extractions, and the impacts associated with them, and may increase them. Policies to reduce extractions will seek to increase resource productivity through all stages of production, and to reduce resource use in consumption.

The key driver for economic decision-making is the market price of goods and services. Henceforth the "ecological truth" must be reflected in the price architecture of the market, rewarding the production and use of goods and services with the highest resource productivity.

Full cost prices of resources must be introduced, e.g. by cost-neutrally shifting taxes and levies from labor to natural

[15] The International Factor 10 Club, 1994, see www.factor10-institute.org

[16] P. Ekins;: "Economic Growth and Environmental Sustainability: the Prospects for Green Growth", Routledge, London/New York, 2000.

[17] B. Meyer, „Costing the Earth? Perspectives on Sustainable Development", Haus Publishers, London, 2009.

resources, thus letting the market drive the competitive process of resource saving.

Not only would resources become worth saving, but discarding waste would also be discouraged through the market, and labor would become less expensive, inviting the creation of new jobs. Moving in this direction requires the introduction of system policies.

In addition to tax shifts, there is a host of additional policy options to support the saving of natural resources: e.g. Favoring dematerialized goods and services in governmental purchasing; avoiding subsidies that lead to un-necessary investments in materials and land use; adjusting standards and norms; reviewing the freedom of moving and investing capital world-wide; restricting short term planning and profit taking; reviewing the environmental implications of personal property and property use rights.

Policies attempting to stabilize the relation between the economy and the ecosphere should be targeted on material mobilization and extractions, and *not* on emissions or residuals.

On the *international* level, a process is needed to define and harmonize time paths of targets for the consumption of natural resources, measured in tons per capita (similar to the greenhouse gas reduction commitments that are being sought under the UN Framework Convention on Climate Change), and the use of land, measured in square meters.

Perhaps the best international policy approach would be to introduce internationally marketable permits for use of natural resources, with the number set to decline by 2050 to the *per capita* limit mentioned above. The permits would be traded only between countries. Countries would be invited to join this system as soon as their resource use exceeded the average per person global allowance on the declining trajectory to 2050. The group of countries deciding in favor of participation in the system, will tax all import goods from non-participating countries to avoid distortions in international trade, provided that these countries have a use of raw materials per capita that is above the average of those countries in the system. The tax would also be applied to those countries that had failed to develop an adequate system for the measurement of resource use in their territory.

On the *national level*, countries would be free to choose their policy mix that is in line with the countries economic constitutions, cultural and trading conditions. But a central part of the policy mix should be the use of economic instruments in the tradition of the "economic- environmental tax reform".

Such a scheme would doubtlessly need much elaboration to cope with the complexities of the real world. It will also be necessary, in parallel with the broad scheme of resource taxation and the trading of resource use permits, to maintain the local regulation of specific substances according to their hazardous properties.

In this way the resource and environmental policy framework would both regulate and reduce the macro-material impacts which are currently so threatening the future of humanity, while continuing to control the local environmental hazards of pollution.

IMPORTANT ACTIONS REQUIRED

Full-cost pricing of food, goods, energy, infrastructures, and services, e. g. by shifting taxes and levies from labor to natural resource, and curbing subsidies

Make it profitable to produce, install, and consume eco-friendly food, goods, infrastructures, and services

Encourage and support supply- and demand-side eco-innovation

Enter into international negotiations with countries willing to control the mobilization and use of natural resources with the aim to establish a contractual agreement within a sufficiently strong economic block that can entice other countries to join later for security and economic reasons. To the extent necessary, re-negotiate or repeal membership in international organizations with charters that fail to recognize that the economy must be constrained to function *within* the limits of the environment and its resources.

Note: A 10 min film on resource productivity is available under
http://www.umweltdaten.de/filme/Flow-EN-512K-Stream.mov

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Properties of products that need be considered for sustainability

** Indicates that MIPS covers this property.*

MANUFACTURING
* material intensity (materials, processes)
* energy intensity (materials, processes)
* renewable resource inputs
* useful material outputs
* waste intensity
* refusal rate
* transport intensity
* packaging intensity
hazardous materials

USE, CONSUMPTION
* material throughput
* energy input
* weight
* self control, self optimization
* multi-functionality
* potential for subsequent (different) uses
* potential for joint (e.g. several families) uses
size
area coverage
dispersive hazardous material outputs
**** longevity***
** availability of spare parts for extended time period*
** surface properties*
** anti-corrosivity*
** repairability, exchangeability of parts*
** structure and ease to dis-assemble*
** robustness, reliability*
** likelihood of material fatigue*
** adaptability to technical progress*

AFTER FIRST USE
** low MIPS collecting and sorting potentials*
** re-usability*
** usability for different purposes*
** re-manufacturing potential for same use*
** material composition and complexity (ease of re-cycling for chemical/metallurgical reasons)*
** re-cycling potential of parts and materials for same or other uses*

DISPOSAL
* combustion potential (usable energy outputs)
potential for composting
impact on environment after disposal

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The author has been awarded the coveted Takeda World Environment Award in 2001, together with Ernst Ulrich von Weizsäcker. He was originally trained as a nuclear chemist at the Max Planck Institute for Chemistry. After receiving a PhD, he worked with Nobel Price winner Sherry Rowland at the University of Kansas, and as a faculty member of Purdue and Tennessee Universities, while serving as a consultant with Oak Ridge National Laboratory. With ORNL and TVA he founded the UT Environment Center and was its first director. At the newly created German Environment Agency he became responsible for coordinating env. research, and later for developing and applying the German chemical substance control legislation. At the OECD he was in charge of harmonizing chemical control management for the Member states. He subsequently became leader of the Technology, Economics, and Society Program at the International Institute for Applied Systems Analysis, IIASA. where his principal task was to support the development of market economic legislation in (former) COMECON countries in close cooperation with the chief economic advisor to President Gorbachov. Realizing that western environmental protection laws could not lead to sustainability, Schmidt-Bleek developed his Factor 10 dematerialization concept, including indicators such as ecological rucksack and MIPS. He build up the Wuppertal Institute with with Ernst Ulrich von Weizsäcker as his first Vice President. In the 90ies he became the founding president of the Internatioal Factor 10 Club and the Factor 10 Institute in the Provence. He initiated the World Resources Forum Davos and the Lindau Group, an association of concerned economists interested in economic perspectives of sustainable development. Schmidt-Bleek has published hundreds of papers and some 20 books in a number of languages.

BILD DER WISSENSCHAFT named Schmidt-Bleek in 2006 „Father of Dematerialization“; DER SPIEGEL called him recently „Doyen of the German Environment Researchers”.“