Key conceptual points and
initial recommendations for WG3

CRITICAL FACTORS AND PROCESSES COUNTERACTING TO RESOURCE EFFICIENCY ENHANCEMENT EFFORTS

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Efficiency improvements and consumption growth: insufficiency of the *Relative Decoupling*

The problem of degradation of the non-renewable or conditionally renewable natural resources was recognized long ago. There are well-known historical examples of dramatic ecological and social consequences of the overuse of certain local/regional resources. Recognition of such problems has resulted in development of response policies for increased *natural resource efficiency* (NRE). Lately both the problems and the need for such responses have reached global levels. Thanks to various efforts the NRE was gradually increasing, policymakers and business people proudly demonstrated figures for *Relative Decoupling* of economic performance (at national/company level) from the material and energy use. But in many cases the increasing consumption steadily lessened the volume of the efficiency gain or even fully outweighed it. The aggregated use of these resources or the use of specific resources remained still growing only with some decline from the BAU trends. The majority of NRE policies has contributed only to slowing down the resource degradation and to expanding the assessed time horizon of running out of specific finite resources (fossil fuels, rare earth, fish species etc.)

Concrete *resource efficiency policies* include those related to production methods, new technologies, economic instruments, policies for strengthening the public awareness and changing unsustainable consumption patters etc. In particular, there are lots of new technologies which utilize resources with much higher efficiency e.g. for electricity production, motorized mobility, lighting, heating, cooling. At the same time demand for these services is sharply increasing and eventually resulting in overweighing the achievements provided by the increased NRE. Relative efficiency gains measured not only for specific resources, but also for overall material use at sectoral, national or even at global levels and for this purpose complex indicators have been introduced.

The problem of decoupling is discussed in many literature sources, the relevant policies are also presented in many national programmes and these are referred to in international documents adopted by multilateral meetings or in relation to multilateral agreements. The limits and future exhaustion of finite natural resources was addressed already in 1972 at the UNCHE[1] or in the famous analysis by the Club of Rome. The UNCED[2] in 1992 was formulating it more concretely and 10 years later the WSSD[3] admitted that the unsustainable consumption patters are key drivers for these adverse processes and agreed on the development of a 10-year framework of (dedicated) programmes. The EU has reiterated the general objective within its Thematic Strategy on the sustainable use of natural resources (2005) to ensure "that the consumption of resources and their associated impacts do not exceed the carrying capacity of the environment and breaking the linkages between economic growth and resource use", however, it was also adopted without concrete targets.

More ambitious and comprehensive approach is necessary by taking into account all the drivers and critical factors together with their effects in the general eco-efficiency programmes with due consideration of the interlinkages (pricing, eco-taxes. consumer info, international technology transfer etc.). This is relevant for the existing policy instruments at EU level (SCP, SPP, EAP etc.) and at global level (UNEP initiatives, followup process to the WSSD etc.), and for the upcoming programmes: the EU's flagship initiative and the preparations for the UNCSD. Particular factors mentioned below only further reinforce or partially explain the above-mentioned adverse processes.

[1] The principle 5 adopted by the UNCHE reads: "The non-renewable resources of the earth must be employed in such a way as to guard against the danger of their future exhaustion and to ensure that benefits from such employment are shared by all mankind."

[2] Agenda 21: "4.18. Reducing the amount of energy and materials used per unit in the production of goods and services can contribute both to the alleviation of environmental stress and to greater economic and industrial productivity and competitiveness."

[3] JPoI: ".. to accelerate the shift towards sustainable consumption and production to promote social and economic development within the carrying capacity of ecosystems by addressing and, where appropriate, delinking economic growth and environmental degradation through improving efficiency and sustainability in the use of resources and production processes"

Material input to a product: the *Rucksack Factor* and the specific *Virtual Material factor*

The idea behind the *Ecological Rucksack* (RS) or ecological burden concept is to measure the amount of all materials treated or used somehow in relation to a product or service for its full life-cycle. The more general term for this concept is the *Material Input Per (unit of) Service*. Sometimes for the materials not directly utilized (embedded) in the particular product, the term of "hidden material flow" is also used. The general methodology coupled with such approach is the *Material Flow Analysis* (MFA). More precisely speaking the ecological rucksack of a product is equal to the total weight of the material input (directly or indirectly used for the lifecycle of the product) minus the weight of the product itself. If the product consists of various materials then all should be taken into account according to their weight and their hidden material flow factor. The *Ecological Rucksack factor* is the ratio of the weight of the product material to the full material input. Various forms of "using" the materials include extraction, processing, transportation or deposition in the whole process of production and delivery to the "point of sale".

Many examples could be mentioned for the eco-Rucksack, including coal mining (as digging large rock tunnels in order to mine coal, but the rest of rocks do not directly enter the production process and the product itself), canned mineral water with international brands, timber and furniture, caviar, precious stones and watches, rare earth and modern info-communication technologies, materials for jewels. One of the more frequently quoted case is that of "the platinum and the catalytic converter" ("The Fossil Makers" by Schmidt-Bleek, 1993): "In order to extract one gram of platinum from a platinum mine, for example, we must displace and modify 300,000 grams of rock. Without platinum we would not have the catalytic converter in our automobiles. Two to three grams of platinum are found in one such catalytic converter, in addition to high-quality steels, ceramics and other materials. Thus, the ecological rucksack of the catalytic converter, i.e. the total amount of material translocated for the purpose of constructing it, amounts to about one metric ton of environment. This means in effect that the catalytic converter burdens the automobile with as much matter as the car itself weighs."

The volume of the Rucksack is a single aggregated indicator like the eco-footprint: very good for simple demonstrative purposes but it should be used carefully when somebody is interested in crucial details of the nature, characteristics, availability of the materials accounted for a product. The calculation of the RS-factor is much more sophisticated for more complex products, and consequently, it is more difficult to analyze the various combined options for achieving better material productivity for a particular product. There are many other environmental parameters characterizing the various materials besides the total weight of hidden materials flows related to their end use in a product, i.e. it is not easy to compare two or more different raw materials as it would depend e.g. on the accessibility, rareness, energy intensity of their extraction and preprocessing etc. For the RS-factor it is indifferent to some extent (or at least not easily distinguishable) whether the products for the same purpose have different qualities that is e.g. those are more or less endurable. The RS-factor cannot take into account the usefulness of the product/service, which is important but anyway a rather subjective characteristic of the particular product/service. Nevertheless, a product/service that meets basic human needs or essential e.g. for human health has obviously of a different category from something that cannot be considered as part of this category. In this sense, the RS-factor cannot be used for comparability analysis for goods, which are provided for different human needs.

The RS-factor is increasing e.g. when one component of the materials used in its production process becomes less easily extractable or accessible, and this factor is decreasing with enhanced material recycling. Sometimes a simplified methodology is used w/o full lifecycle approach. i.e., for the assessment of the hidden material flows only for the production of a commodity without taking into account the extra materials (and energies) used for the deposition.

The term of *Virtual Material* (VM) is also used in specific context and it means the total amount of a particular material or substance used directly or indirectly for producing a commodity. The most frequent application of the latter concept can be met in relation to water resources, especially for the demonstration of *Virtual Water* transfer coupled with international trade of food etc.

The lost gains from increased resource efficiency: the *Rebound Effect*

The *Rebound Effect* (RB) was realized when it turned out that some energy efficiency related technology improvements did not resulted in the proportional reduction of the energy consumption. The savings achieved by means of more material/energy efficient products or services were lessened partially or fully by increased demand for such products/services or by more intense use of the new products as compared to their "outdated" versions. In a sense, the RB is a sort of negative feedback weakening the process of NRE improvement. A *direct rebound effect* occurs when higher efficiency lowers the costs of a resource used in course of production or consumption of a commodity, but leading to higher demand for and consumption of that commodity. This phenomenon is generally explained by behavioral factors at individual and societal levels. If the RB is less than (or equal to) the "original" or expected efficiency gain then it is also called the “take-back” factor; if the RB overrides the expected efficiency gain (which is a rather exceptional case) and actually leads to even higher resource consumption then it is called the Jevon`s paradox (W.S. Jevons, 1865: "The Coal Question"). According to some studies, the direct RB factor is usually between 10-50%.

For example, vehicles with increased fuel efficiency lower the cost of consumption of the fuel for same mileage, but leads to increased fuel use from more driving (due to the perception that driving became cheaper). In general, this phenomenon is called the substitution effect. There are many other simple (or oversimplified) demonstrative examples, however, in general, the causes of generating or reinforcing the RB at social level are rather complex and consequently, their assessment and effective management is also rather complicated. RB happens also in relation to production typically when more products/commodities are the result by introducing a new technology utilizing more efficiently some material component per unit of product. Usually only the direct positive effects are accounted for but those implications are overlooked which are related to the higher environmental pressure stemming from the utilization of more products (e.g. in case of more fuel-efficient airplanes with higher cargo or passenger capacities).

The term and the analysis of the *indirect rebound effect* is even more sophisticated as it is the consequence of the spending the extra income from the savings from better NRE of a particular commodity for any kind of resource-intense products/services. It occurs hypothetically, when for example, savings from buying and using more energy-efficient household appliances are spent for buying additionally one more appliance with another service.

There are important general *response frameworks*, which directly or indirectly mitigate the problem of the Rebound Effect as part of the overall resource problem (like the Factor-4 or Factor-5 concepts) and also some relatively simple measures e.g. at individual (personal) level. Set of various economic measures (adequate eco-taxing, elimination of environmentally harmful subsidies) leading to proper resource pricing is one of the most common instruments, which can be used at national level. For individual level, it is best to quote the simplest idea (M. Bloch: Green Living Tips.com): "To help minimize the green rebound effect in your own life, just ask yourself this simple question before purchasing a product: It's green, but do I really need it and do I need it in this quantity?"

There are *international aspects* of this problem, as well. When new technologies are installed and the older, less efficient (but still usable) technologies are replaced and transferred to less effluent partners, it may lead to a special form of "transboundary" RB. It is also true for certain products (used cars, trucks; pesticides, which will not be used "at home" because of already more rigid regulations of the country of origin or for other reasons). Such technologies or products can contribute to well-being, relatively higher standards of living or even to poverty reduction of the recipient community (e.g. in terms of energy poverty). But in global sense, such a transfer will increase the overall eco-pressure. At least, this secondary RB effect should also be taken into account together with relative NRE gain achieved in the country of origin. The consequences are even more controversial when the same commodities/goods are imported in increasing volumes but produced in the country being the recipient of the less efficient, outdated technology. Such a transfer only formally decreases the natural resource use and adverse environmental impacts of the “country of origin”.

Recommendations

a) *Absolute decoupling*. As the relative gains achieved e.g. by means of various NRE technologies only slow down the rates of overuse and degradation of those resources, more significant approaches are necessary in order to halt/reverse these adverse processes. Moreover, the *root causes* of the problem should be dealt with, namely the unsustainable consumption patterns should be changed. National and international policy programmes should strengthen efforts towards enhancement of resource efficiency with due regards to socio-economic processes, which counteract or even outweigh the relative efficiency improvements and the *relative decoupling*. In critical cases already the *limitation of resource use* is unavoidable that should be backed by universal international agreements. In general, the *developed countries* and in particular the members of the EU have special responsibility in this regard that should be reflected e.g. in the outcomes of the upcoming UNCSD and in the EU's resource efficiency instrument, which is a flagship initiative under the Europe 2020 Strategy.

b) *Material flow analysis*. Methods of MFA should be more broadly applied and publicised. This can be used for identification of the weakest points of the given technology, for evaluation of the efficiency effects of innovative approaches for various segments of the material flow or, in general, for better awareness of the full cycle and volume of utilization of the relevant materials and the need for improvements in this regard.

c) *Interpretation of the eco-Rucksack factor*. Reduction of the overall material use, i.e. the RS for a product or service generally results in higher eco-efficiency, however, a rather careful interpretation is necessary, otherwise, for instance a significant reduction of one material input can be outbalanced by increased utilization of another but more essential material that is very rare, not-replaceable, non-renewable or which utilisation is much more essential for other purposes.

d) *Virtual material content*. Assessment of the volume of a specific material used in some way throughout the production of a commodity is the simplest component of the RS and in some cases it can very effectively demonstrate the eco-pressure regarding that product. It is recommended to assess it more broadly, in particular, in context of virtual water or virtual carbon.

e) *Extended eco-labeling*. It would be useful to broaden the various forms of eco-labeling in case of certain products by means of providing information on the amount of RS or specific VM factors (and perhaps also by taking into account the ways/methods of translocation and use of materials that can also lead to the better recognition of the "fair-trade" from ecological point of view).

f) *Rebound effects related to consumption and production*. The rebound effect stemming from enhanced consumption should be mitigated by a mix of proper policies such as the increased public awareness, provision of exact resource consumption information for the former and newer products, measuring of the saved amounts of resources (energy, fuel etc.), using adequate resource taxes, elimination of harmful subsidies etc. More attention should also be paid to the production related RB effect, when e.g. more products/commodities are the result by introducing a new technology utilizing more efficiently some material component per unit of product.

g) *Rebound effect of international technology transfers*. It is recommended to more closely quantify and mitigate the RB effect from the transfer of less efficient or more resource-intense (and more polluting) technologies or moving production line to and importing the products from less effluent, environmentally less regulated countries.

h) *Policy integration*. All critical factors counteracting to NRE enhancement efforts (or more generally, to the sustainable use of resources) should be taken into consideration in sectoral policies, and the corresponding response requirements should be integrated in the sectoral policy programmes. In particular, this would improve the effectiveness of policy instruments and the measures to tackle better resource efficiency and its rebound effects.

i) *Public awareness*. It is especially important to raise public awareness concerning the relatively high material/energy use for the “sake” of certain products or services. This would reinforce the patterns of environmentally (and socially) responsible consumption, i.e. the consumer’s environmental attitude in context of his/her choices and ways of using of various commodities. This is relevant for all factors related to resource use (in particular for the Relative Decoupling, the eco-Rucksack and specific Virtual Material factor, and the direct and indirect Rebound Effect).