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Between Energy and the Environment

Raw Materials: Crucial to the Future of the European Economy?

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Might the title of Leo Tolstoy's wonderful, visionary parable, «How Much Earth Does a Man Need?» these days be paraphrased as «How Much Raw Materials Does a Man Need»?

Here in Western and Central Europe we enjoy a lifestyle which has achieved an unprecedentedly opulent standard, thanks to the ready availability of foodstuffs, fuels and devices from all over the world. We can afford the dubious luxury of not having to worry about their means of production nor about future supplies. We behave like naive neo-colonialists who don't want to know anything about how much water, soil, fuel or minerals used in every part of the globe are involved in our consumption. Reasonably priced «modern» foodstuffs, innovative high-tech products, and an unshakeable faith in permanent economic growth distort our view of the mutual dependency between development and resources. As a result, agriculture – built upon the historic technology of using the energy of the sun and, by means of controlled photosynthesis, transforming water and carbon dioxide into agrarian raw materials, i.e., the foods we need – is increasingly becoming a factor of global risk: agrochemicals and the use of machinery are destroying the soil, monocultures threaten species diversity.

As a consequence, not only is the energy balance in deficit (in contrast to the energy collected by plants, far greater quantities of technological energy are being expended), but the resulting output of greenhouse gases is frighteningly high. So lauded until just recently, the manufacture of so-called bio-fuels – with Indonesian palm-oil production and its partly government-subsidized use as a fuel providing a negative example – is increasingly being recognized as poorly thought-out farming with counter-productive consequences. The intended reduction in emissions of climate-changing gases, so hopefully anticipated under the term «mitigation», hardly contributes at all to reducing the use of fossil fuels (cf. the Empa report by Rainer Zah, published just a few months ago).

Our planet is in a feverish state. Linked to our hunger for energy is the fact that the past two or three decade have brought an almost unbelievable flood of goods. The material needs of thre world's population, and the demands of the so-called «developing countries» for their right to a fair share of prosperity, is pushing the global economy to its outer limits. Based upon the projection that the world's population will reach about 9 billion by the year 2050, the Swedish documentary film «Our Planet» (2006; dir. Michael Stenberg) estimates that mankind would need five (5) Earths in order to achieve anything resembling an equal distribution of resources and the resulting standard of living for all.

Our technical capacities are limited by the availability of resources. Even the production of the almost universally important mass products steel and cement (last year more than 1.2 billion tons of steel and about 1.6 billion tons of cement were produced, about a third of each in China) contributes more than 12% of global carbon dioxide emissions (the figure varies depending upon the technology used, and there is huge potential for reductions). Such everyday items as cellular phones, computers and automobiles are produced by the millions, and the almost immeasurable streams of materials needed in their production are providing boom times for the transport industry, and at the same time causing an explosion in the energy and carbon-dioxide «footprint». The expected consequences of the resulting climate change are currently a hot topic of discussion.

Is the successful era of Europe as a raw-materials importing and refining colonial power coming to a close? More or less realistic projections reveal dubious prospects for the future. Europe is dependent to an enormous extent on raw materials imports in the areas of agriculture, energy and metals. Along with its extensive financial services, Europe manufactures and profitably exports mainly technically complex products, and the profit margins are more or less guaranteed by high standards of know-how, technology and production which are still competitive today. But their relatively high wage costs, and the global availability of technological know-how, are factors which are forcing European producers into an increasingly harsh competitive situation with newly rising industrial nations.

Despite all the sensible environmental, social and political reservations, the manufacture of high-tech products (mainly by large corporations) is being out-sourced to less expensive production sites all over the world. Only a small percentage of automobiles, consumer electronics and mobile phones is now being turned out in the traditional high-technology regions. And what about those raw materials which are absolutely essential for the production of industrial goods – especially metals, the importance of which has hitherto been largely overlooked ? We act as if those functional materials were available in unlimited quantities beneath the soil, their extraction and preparation sometimes more expensive and sometimes less, but in no way limited. And yet, although it creates monopolies which are beyond either economic or political control, the current tendency toward concentration or merging of such large mining companies as Rio Tinto and BHP Billington is drawing little public notice or criticism.

What do all these trends signify for us as individuals, for European society, and for our world? What factors have been, and are being, underestimated, neglected or repressed? What economic perspectives are opening up, for good and for ill? Do we need to develop new strategies, to work out new technological solutions, or to think in different dimensions entirely?

The technical dimension

Global sales of mobile phones are projected to be approximately one billion units in 2008. About half of them will be produced by the Finnish firm Nokia. If one takes the trouble –which appears possible only at universities these days – to work out what raw materials are needed for this production, one is confronted by some noteworthy facts. For example, in addition to plastics, dyes, lacquer and many additives, each and every unit contains more than 20 different metals, many of which are totally unfamiliar to most people, such as yttrium, rhodium, indium, gallium, etc. Each of these metals has a complex technical and economic history, and each, thanks to its particular characteristics, fulfills a specific function. The logistics involved in procuring all these metals and applying them is impressive testimony to the organizational and coordinating abilities of global industrial enterprises.

At the same time, that situation reflects the unprecedented dynamism of today's raw materials utilization. In the past twenty or thirty years, applications have been found for at least 30 previously largely unused metals , applications arising from new technologies and finding their place in mass-produced products. Many of those metals are rare, with annual global production of less than 1,000 tons. They are often used in minute quantities, as more or less essential «spice metals», so to speak, their cost barely reflected in the final price of the finished product.

But there are some unanticipated pitfalls and risks in this high-tech, hundred-billion-dollar business: Some of these metals, rare anywhere in the world, yet for which there are no viable substitutes because of their specific properties, are produced with great difficulty in just a few mines, as trace metals alongside more common minerals. A textbook example is indium. In the form of an electrically conductive gas, indium-tin-oxide, it finds application in the screens of mobile phones and in flat-screen displays, and in other industries, such as photovoltaics and semiconductors, it is used as copper-indium- (di)sulfide or copper-indium-gallium-(di)sulfide or other chemical combinations. In 2007, worldwide production of indium was less than 500 tons, but there was demand for about 900 tons. As a result, the price of indium is extremely volatile. The reserves available with traditional mining techniques appear to be very small, and a supply bottleneck can be anticipated in just a few years – unless the mining industry invests in new extraction techniques and production facilities. But since the total available quantity of this trace metal is quite small, the economics of creating capital-intensive new facilities are dubious. The obvious idea of quickly replacing indium with another metal bearing closely analogous properties is rather naive; finding and producing a substitute for a functional material is generally complex and expensive.

Taken to extremes, important industries could be hampered by the shortage of a metal which, though functionally essential, is available only in very limited quantities and therefore economically marginal. And the hope of stretching the supply of indium or other essential metals through recycling is blocked by the highly opaque nature of recycling operations in the case of electronic equipment. Large quantities of electronic equipment are collected, but then often sent off, legally or illegally, to Africa, India or China, where, frequently under atrocious working conditions, extraneous parts are melted down or manually dismantled in order to get at certain basic materials, especially copper. In India and China, admittedly, industries have already been established which also extract trace metals from used equipment and thus function as so-called secondary mines. But in Europe, Japan and North America, given the high wage levels in those parts of the world, it is unlikely that a profitable recycling of strategic metals will be possible.

The socio-economic and ecological dimensions

Since the catalytic converter was successfully introduced at least 20 years ago in order to improve air quality in regions with high levels of automotive transportation, little attention has been paid to the origins and availability of its component metal platinum. That precious metal also serves vital functions not only in the jewelry industry, but also in pharmaceuticals and other industries. Global annual production of about 200 tons (in mines such as that at Norilsk, Russia, which have created enormous environmental damage) is so small, that prices are exorbitantly high. Today one kilogram of platinum costs more than $50,000. And substitutes which sometimes crop up on raw materials markets, such as palladium, ruthenium or rhodium, are even scarcer than platinum. In nature, all these metals are found in extremely dilute form in their respective ores; for example, as much as 10 tons of ore are required to produce only a few grams of platinum. This is economically viable only if large quantities of more common metals, such as nickel, zinc or copper, can be extracted at the same time and sold for technological applications.

The use of platinum in automotive catalytic converters or in pharmaceuticals results in at least minimal dispersion of fine particles of the metal into the biosphere (it is not yet known whether soluble kinds of platinum or nano-particles of the metal are bioactive). Known as «dissipation», this phenomenon means that platinum is dispersed so finely into the environment that it cannot be re-extracted from it. Aside from still-unknown effects on human and animal life, altered growth conditions for plants and thus possible impacts on the entire food chain, current methods of production and utilization of these trace metals result in the steady, irreversible loss of valuable reserves. That is unquestionably not only economic and ecological, but also historical nonsense, since what is at stake here are materials essential for future technologies – in the case of platinum, for example, in the catalytic converters for hydrogen fuel cells.

Aside from the risk of dissipation, there is another grave factor: the often incredibly polarized social conditions along the manufacturing chain from initial metals extraction to final recycling. At the beginning and end of that chain, i.e., in the mines and in the recycling areas, people live and work under the harshest conditions, while in between, in trade with the products in which the metals are utilized and in speculation with the raw materials themselves, people reap fat profits – all in all, a highly unstable economic structure which inevitably invites social conflict.

The geopolitical dimension

The consequences of Europe's dependence on imports of strategic raw materials, mentioned at the beginning of this talk, can be grasped only by understanding the geographic spread and geopolitical significance of global raw material reserves. Such an examination makes it clear that many strategic metals essential for high-tech products and processes are produced in just a few mines and that those mines are often located in politically volatile regions, or else that certain countries enjoy virtually a monopoly on some of those materials.

For example, China has at least 90% (!) of the so-called rare metals needed by the lighting industry for luminous bodies such as incandescent light bulbs, neon lights, compact fluorescent bulbs, as well as for the up-and-coming LED systems that hold so much promise for energy efficiency. The economic consequences of this fact are considerable: A large percentage of luminous elements are now produced in China; this confronts such major producers as Philips and OSRAM with the unpleasant prospect of frequently and erratically fluctuating export duties. On the other hand, China has an insufficiency of copper. Beijing is trying to compensate for this deficit by a clearly expanding engagement in Africa, especially in those countries with large copper reserves, and existing political conditions there are accepted with the pragmatism suitable to the purpose.

Such developments are by no means unusual. They will occur with ever-increasing frequency because of global economic realities, and will be further intensified by investment activities on the part of such new economic powers as Brazil, Russia, India and China.

Perspectives

In his article *Die Grenzen des materiellen Wachstums* («The Limits of Material Growth»), which appeared on 4 Feb. 2008 in the daily *Neue Zürcher Zeitung*, Meinrad Miegel rightly attacked the self-overestimation frequently found in the CEO offices of some major corporations. That overestimation is due in part to sheer ignorance, but also partly to a deliberate repression of the fact that the realities we have been discussing are linked directly to our individual behavior, our (purchasing) decisions. It is my purpose to counter that know-nothing stance by introducing a perspective in which the human interaction with agricultural, mineral and energy raw materials is given a spatial-temporal context, seen as an historical process, so to speak. This stock-taking (real or virtual) permits us to evaluate imminent risks, such as raw materials shortages and dependencies or social and ecological variables. It also enables us to realistically estimate opportunities for the future.

Those opportunities reside in increasing our economic and ecological efficiency, reducing dependencies through innovative processes, and – especially in global manufacturing chains – introducing measures aimed at social depolarization. In the realm of both national and corporate economics, we must as soon as possible develop logistical systems which, through forward-looking global methods, make it possible to integrate at least strategic raw materials into the overall circulation of materials in our global economy. This requires thinking and researching in expanded dimensions, and training all actors in the process to meet the demands we face.

Only the interplay of pro-recycling, ecologically efficient design of products and processes, and the far-sighted recognition of the essential needs of human life, can guarantee economic prosperity. In this sense, raw materials are not only crucial factors but also reliable signposts for forward-looking solutions to our own needs and those of future generations.