Green Business: An A-to-Z Guide

Dematerialization

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The concept of dematerialization refers broadly to the reduction of materials used by society over time. Definitions of the term *material use* vary, but generally include some estimate of ecosystem appropriation and waste generation. Dematerialization studies have been done for products, businesses, regions, nations, even the globe. Measures of **[p. 128 ↓]** dematerialization are often expressed as relative, rather than as absolute values. Such relative values, often called "intensity factors," express total material use per unit of economic output. It should be noted that with the steep upward curves typical for economic output and population, declines in relative values may be visible even as absolute materials use continues to climb. This makes the scale and scope of analysis crucial when measuring dematerialization.

Background

The study of dematerialization to date has largely focused on minerals and their use. The work, particularly in the United States, has been largely empirical and was often produced for national security assessments. Scientists at the Wuppertal Institute in Germany were the first to expand on and develop the concept by proposing "material input per service unit." This measures both the direct materials embedded in products, as well as the indirect materials used throughout the stages of the production process. Hidden flows of materials, such as mining waste, are included. This "ecological backpack" approach traces five major categories of materials: (1) abiotic raw materials (e.g., minerals, fossil fuels, and excavation residues); (2) biotic raw materials (e.g., farm and nonfarmed plant biomass); (3) soil movements (e.g., erosion); (4) water use; and (5) air (e.g., combustion by-products). So, in essence, all stages of production, including disposal, are incorporated.

A primary appeal of dematerialization is that, through technological innovation, there is the possibility of decoupling economic growth from material consumption. This decoupling is often expressed as a "Factor X." It is observed either as a slowing of material use as the economy continues to grow (i.e., declining intensity), or theoretically as a complete break where overall material use actually declines in spite of growing economy. Noted energy expert Amory Lovins maintains that it is technically feasible to double economic welfare while halving energy use across 50 different economic activities. Other scientists argue that with lifestyle changes and technological innovation, much higher factors can be achieved.

Most dematerialization efforts hinge on substituting conventional energy sources and materials with “lighter” alternatives, such as using fiber optics instead of copper in telecommunication networks. However, this substitution may not lead to reductions in the use of the replaced material. Although use of fiber optics has displaced demand in telecommunications, overall use of copper has increased for uses like electrical wiring. Other “substitutions” can be much broader, such as the emergence of digital delivery of music, movies, and even books. The complexity lies in assessing whether such change actually leads to overall trends of dematerialization.

Measuring Dematerialization: Scope and Scale

The system boundaries—in essence scope, temporal, and geographic scale—are fundamental in terms of shaping how dematerialization is measured and assessed. For example, measuring the material mass in the product cycle at a given point in time can mislead if large amounts of materials were displaced long ago from mining activity, or if large amounts of end-of-life wastes will be disposed of at a later date. Do we incorporate air and water as appropriated from ecosystems? And if so, how do we measure this? How do we model energy or human work? Both of these can be substitutes for appropriation of materials.

[p. 129 ↓] One way to address this challenge is by incorporating “exergy” as a representation of the level of transformation that materials have already undergone from their natural state. The energy embedded in materials is essentially included and can be applied systematically across a large range of materials. But this does not resolve the challenges of scope, particularly for the purpose of relating materials use to particular economic welfare values.

Economic welfare is typically measured as gross domestic product (GDP). The measure is clear enough until one considers how to represent specific economic functions versus materials use at greater levels of detail, as in assessments of trends or structural changes. It is also often difficult to identify equivalent economic functions over time. From the standpoint of dematerialization, similar economic functions are routinely shifted to other economic sectors. In the digital media example, entertainment moves out of theater establishments and into retail (e.g., big screen, high-definition televisions), telecommunications (e.g., information and communications technology, digital broadband), and household energy consumption. Nevertheless, assessing the level of dematerialization achieved by digital media requires making a complex cross-sectoral assessment.

At the level of individual businesses, declines in material intensity have been achieved primarily through material reduction and substitution. The mass of the standard aluminum beverage can, for example, has declined for some time as new alloys are discovered that give adequate strength despite thinner container walls. Companies can often save money and reduce environmental impact through basic material reduction strategies. For example, by reshaping and reducing the cap size, Nestlé Waters, North America, has thinned the plastic in its half-liter water bottle, claiming that it uses 30 percent less plastic than the average half-liter bottle.

Another well-known example of dematerialization in green business is Interface Corporation. It achieved dematerialization by designing carpet in tiles so that carpet could be selectively replaced in high-traffic areas. This eliminates the substantial waste associated with recarpeting an entire floor. New materials and systems have also been implemented to recover materials from used tiles to produce new ones ("closed-loop" manufacturing). In *The Ecology of Commerce*, Paul Hawken explains that the central insight here was reframing the carpeting product as instead the "service" of floor covering. Conceptualizing products as services can lead companies to strategies that create value with less material. In the green business movement, generally, *dematerialization* has become a favored term. In their book, *Natural Capitalism*, Paul Hawken, Amory Lovins, and L. Hunter Lovins outline the many forms dematerialization can take, and introduce green business principles, such as cradle-to-cradle design, biomimicry, just-in-time production, and extended producer responsibility.

Many dematerialization studies are executed at a national level. Some studies generally indicate dematerialization occurs with the shift to a service sector economy. But these dematerialization studies generally restrict their analysis to a particular geographic scale, neglecting to incorporate, for instance, the embodied energy within goods that are manufactured overseas and imported. However, Cleveland and Ruth find no compelling evidence that the U.S. economy has decoupled significantly from material inputs. There is a need for more dematerialization studies at a multinational or global level to more fully assess whether economies are actually dematerializing. Without such evidence, it begs the question, “Is dematerialization in industrialized society dependent on increased materialization elsewhere?”

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Trends and the “Rebound Effect”

After evaluating 40 empirical studies of dematerialization, Cleveland and Ruth concluded that dematerialization trends were unclear, due to the varying scale, scope, and rigor of the studies. A decade later, this situation has not markedly improved. Nevertheless, certain factors broadly driving or inhibiting dematerialization can be identified.

The mining and refining of primary ores and fuels has become more efficient. Material substitution through greater use of alloys and composites has encouraged the dematerialization of some products (e.g., lighter aluminum cans). Other strategies include design improvements like miniaturization, greater life spans of certain products, and increased recycling.

In contrast, declining ore grades necessitate greater use of energy or water in the production process (e.g., the substitution of tar sands or oil shale for petroleum deposits). Ironically, the material innovation strategies that initially encouraged dematerialization, with respect to production, may actually inhibit overall dematerialization by shortening the product life or by increasing product complexity in ways that work against recycling (e.g., the proliferation of polymer composites or biopolymers).

Finally, scholars have identified a “rebound effect” (also known as Jevons Paradox), whereby relative dematerialization, such as increased efficiency, actually leads to greater overall consumption. This is often connected to cost, as the material or product becomes cheaper to produce due to greater efficiencies and this, over the long term, induces greater overall consumption. A study led by Robert Ayres found that in every case investigated, increased demand seemed to nullify efficiency gains.

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See Also:

- Best Management Practices
- Corporate Social Responsibility
- Cradle-to-Cradle
- Ecoefficiency
- Ecolabels
- Ecological Footprint.

Further Readings

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