# Saving Grace: Industrial Efficiency

## Lightening Up: Reducing Material Intensity

Most products ultimately provide some sort of service; we own them because they do something for us. If we can get the same service out of fewer goods, or use less energy and material to make the same goods, no sacrifice is involved. Keeping food cold or frozen is the goal of owning a refrigerator; surrounding that food with a quarter ton of metal is a side effect, not a goal.

90% of the material by weight that humans extract from the environment is discarded before final products reach the consumer. 90% of finished products are discarded within six months, Real thermodynamic efficiency of material output over input is not 94%, not even 15%, but around 1%[22]. 99% of all material extracted is discarded within six months. If we multiplied our efficiency in material use by ten - we would still discard 90% of all material used within six months - nowhere close to the limits physics set.

Increasing eco-efficiency by lowering material intensity saves energy as a side effect.

Reduce the amount of concrete, metal, wood, and plastic used to construct buildings, and we save energy in cement plants, foundries, lumber mills, chemical refineries before we make one factory more efficient. Reduce the use of heavy farm machinery, nitrogen fertilizer, pesticides and herbicides (without increasing labor costs or reducing food production) and we save energy use in agriculture and support industries before we make one tractor more energy efficient.

Lowering material intensity does not save energy in linear proportion. A tentative rule of thumb is that you cut energy use by about half the factor by which you reduce total material displacement and environmental impact. That is, a factor ten reduction in material use per unit of service results in a factor five reduction in energy use[23]. (I.E. reducing environmental impact by ten (a 90% reduction) results in reducing energy use by five (an 80% reduction). Similarly, reducing material use by a factor of four (a 75% reduction) reduces energy use by a factor of two (a 50% reduction).

What exactly do we mean by saving material? We are not talking about the weight of materials used, but of total environmental impact per unit of service. We are concerned about organic and inorganic material displaced, about water used, about toxins added to the air and to the water table.

The basic methods used to accomplish these savings include the following:

1) Look at the actual service the goods provide. Take a holistic approach, a systems approach and find out if there is a better way to accomplish the same service.

2) Look at the lifespan you can gain for the product. Very seldom does doubling the lifespan of a product require coming close to doubling either the cost, or the impact of materials involved. However beware of increasing lifespan past the point where a good will be discarded regardless of condition.
3) Reduce the total impact of material used in constructing a good. This can mean drastically reducing the weight, but it can mean the extreme opposite. In most cases this can be done in a way that contributes rather than detracts from increasing lifespan.
4) Reduce the amount of waste created while producing the good, the amount of material scrapped. Quite often something as simple as reducing defect rates can pay both economically and ecologically.
5) Try to make the good recyclable on as high a level as possible. That is if possible, make it repairable, so that when worn out it can simply be refurbished into like new condition (again though not to the point where it is repairable in obsolescence). Make it modular, so that parts that may be repaired and reused. Make parts of material that may be recycled into itself - so that waste from a product can be turned into raw material for that same product. Only as a last step, do conventional recycling where you recycle scrap into lower quality goods, such as using old tires for foundation, and turning old cars into scrap metal.
6) Use the principles of environmental ecology. Try to find another industry that can accept any waste you cannot avoid producing as an input for their process. Similarly try and find industries that discard waste products you can use as inputs.

Note that while in some cases you can do all of the above, often you will have to choose, and balance one against another for maximum economically feasible saving. The object in all this is biomimicry. Create industrial ecosystems that work like biological ecosystems - cycling material from cradle to grave back to cradle again - using sunlight as the main outside input, pulling in very small amounts of minerals and water from outside the system, and for the most part circulating the same material over and over again within the industrial system.

As we move to specifics, we won't cumulate savings for industry sectors. Most information available on reducing MI is not structured in such a way as to allow reliable drawing of boundaries. We look at fibers, at fabric made from fiber, at clothes, furniture, and buildings that include some fabric, at transportation infrastructure that includes some buildings and fabric. We look at paper (including paper packaging) and packaging (much of which is made from paper). In short there would be a huge double counting problem if we cumulated, and avoiding it would be the work of a major study in itself. What is obvious is that when you look at the topics – buildings , food, water, appliances and office equipment, packaging, paper, furniture, fiber, and transportation infrastructure you are covering 70%-90% of all consumer goods. It is reasonable to take this as at least a rough sample of the whole.

# End Notes

[22]"..Only one percent of total material flow ends up in, and is still being used within, products six months after their sale..."
Paul Hawken, Amory Lovins, and L.Hunter Lovins, *Natural Capitalism: Creating the Next Industrial Revolution* (Boston: Little, Brown and Company/Back Bay, 2000). p81. Page citations are to the Back Bay paperback edition. Along with Barry Commoner, Amory Lovins is one of the key popularizers of the idea that increased efficiency and more use of renewables could supply most of our energy.

[23] Friedrich Bio Schmidt-Bleek, "Energy," *Factor 10 Manifesto*, Jan 2000). May 2000. *Factor 10 Institute*, 2/Feb/2004 <http://www.factor10-institute.org/pdf/F10Manif.pdf>.p5.