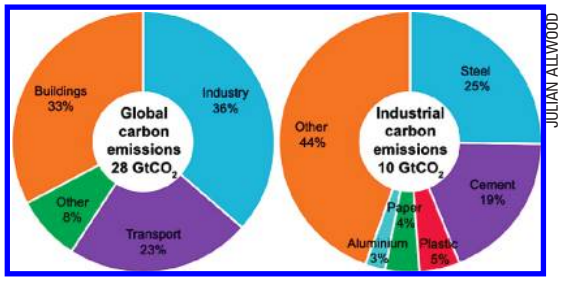
Lowering Industrial Carbon Emissions: What's Really Needed

According to many climate scientists, global mean temperatures can only be stabilized at 2.4 °C above current levels—or less—if carbon emissions drop 50% by 2050. A reduction of that magnitude might limit sea level rise to below 1.4 m worldwide, as predicted by the Intergovernmental Panel on Climate Change in 2007. A number of countries have since adopted this target in their climate change policies, but practical ways to achieve it remain elusive.

Now, Julian Allwood and colleagues report that 50% emissions cuts by industry can only be met with dramatic improvements in material efficiency (*Environ. Sci. Technol.* **2009**, DOI 10.1021/es902909k). In other words, they assert, manufacturers must develop less carbon-intensive products; recyclers must avoid reducing materials back to virgin forms; and society should temper its need for new product designs that relegate last year's model to the trash heap. "One reaction to climate change is for everyone to create smoke screens that confuse the issue, and show the problem is someone else's responsibility," says Allwood, a senior lecturer at the University of Cambridge, U.K. "We wanted to get a handle on the reality of meeting the reduction target, assuming it's applied uniformly across all industry sectors."

According to Allwood, 56% of industrial carbon emissions are driven by the production of just five materials: steel, cement, plastic, paper, and aluminum. Fueled by population growth, demand for these materials could double by 2050, he adds, such that a 50% reduction below emissions today (which is the aim) translates to a 75% reduction in the future time frame.

For their analysis, Allwood et al. considered five plausible scenarios: an optimistic "business as usual" scenario; another that assumes carbon capture and sequestration/storage (CCS) for all process emissions associated with material production; another that explores "non-destructive recycling" methods, (which divert materials from being shredded or liquefied, for instance); one that considers sharp reductions in material demand; and the last based on the development of new, radical, low-energy processes for making materials from scrap.



JULIAN ALLWOOD

Deciding how to achieve a 50% cut of industrial CO_2 emissions in the next four decades requires savvy accounting of how emissions are distributed.

Not surprisingly, their calculations show that business as usual cannot meet emissions targets for any material. CCS, meanwhile, succeeds only for cement. Unlike materials that undergo multistage modifications, cement is ready for use after production, which makes emissions easier to capture. Still, all material industries advocate for CCS over other options because it is the only one that allows them to increase production, Allwood says. The other scenarios can meet reduction targets but also limit production, so they are unlikely to be pursued without external pressure, such as a carbon tax, Allwood adds.

David Dornfeld, a professor at the University of California, Berkeley, calls the analysis sobering. "By shining a light on these options, it removes myths surrounding ways to reduce the impact of material use," he says. "Julian's work shows that if you recycle something by shredding or melting it you're really not gaining much in terms of carbon savings. We have to keep recycling processes closer to users instead of going all the way back to primary processing."

Allwood agrees, adding that melting one ton of steel releases two tons of CO_2. "When you dismantle an old building, there's nothing wrong with the steel," he says. "It doesn't decay with time. Right now, we load it into trucks and reprocess it. Instead we should just clean it up and then bolt it straight back into another building."

Timothy Gutowski, a professor at the Massachusetts Institute of Technology, in Cambridge, MA, says Allwood's analysis reveals significant challenges ahead. Instead of shifting from high- to low-cost inputs in production, he explains, a low-carbon economy can require more expensive, labor-intensive methods. "Some of what we need to do looks more like what we use to do in the past," he says. "And this generally isn't where we're heading."

Still, Allwood strikes an optimistic tone, claiming his real aim is to show how low-carbon industries might operate. "And what we're really looking for are ways that we can still get the benefits of material services, but in ways that require much less primary production," he says.

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