How Inefficient are Modern Manufacturing Methods?

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New analysis from MIT has uncovered some alarming figures that indicate manufacturing methods are "spectacularly inefficient in their use of energy and materials."

It has become obvious that nearly every aspect of future manufacturing operations will have to cut its energy consumption, if not for environmental stewardship then for cutting costs to stay competitive. Manufacturers use nearly a third of the energy consumed in the United States.

Although today's golden age of end-to-end process efficiency suggests that modern-day manufacturing methods are more efficient and sustainable than ever before, new analysis from MIT captured the energy use of 20 major manufacturing processes. The report, published in the journal Environmental Science and Technology, determined that new manufacturing systems are anywhere from 1,000 to one million times bigger consumers of energy, per pound of output, than more traditional industries.

In other words, MIT News reports, making microchips burns through *a lot* more energy than making manhole covers.

The study, funded by the National Science Foundation, covered essentially every standard industrial method, from within cast-iron foundry and injection molding to dry etching and carbon nano-fiber production.

Professor Timothy Gutowski of MIT's Department of Mechanical Engineering, who led the analysis, believes manufacturers have primarily been concerned more about price, quality and cycle time than with how much energy their manufacturing processes consume.

MIT cites solar panels as an example:

> *Their production, which uses some of the same manufacturing processes as microchips but on a large scale, is escalating dramatically. The inherent inefficiency of current solar panel manufacturing methods could drastically reduce the technology's lifecycle energy balance — that is, the ratio of the energy the panel would produce over its useful lifetime to the energy required to manufacture it.*

However, the MIT researchers acknowledged some limiting research factors. Although they gathered data "from heavy-duty old fashioned industries like a cast-iron foundry, all the way up to semiconductors and nanomaterials," the researchers did not analyze production of pharmaceuticals or petroleum, and they only looked primarily at processes where electricity was the primary energy source.

How does this research hold up against the car industry?

Let's look at an American automaker, whose management by proxy would suggest having made some questionable strategic choices over the past decade. That doesn't mean they aren't keeping a close eye on energy consumption, though. Ford Motor Co., for example, recently announced it earned the EPA's coveted 2009 ENERGY STAR Award for the fourth consecutive year.

Ford, the only Detroit automaker not taking federal aid, last year improved energy efficiency in the U.S. by 5 percent, saving approximately $16 million. (Actual savings due to plant shutdowns were higher, but Ford measures energy efficiency as energy consumed per vehicle.)

According to the U.S. Department of Energy, commercial and industrial sites are often among the most voracious users of energy nationwide. The DOE says a typical industrial facility can realize savings of up to 25 percent in process heating systems, up to 20 percent in steam systems and as much as 18 percent in motor systems. Added up, these savings reduce a company's natural gas and electric bills and therefore directly affect profits.

Since 2000, Ford's U.S. facilities have improved energy efficiency by nearly 35 percent — equivalent to the annual energy consumed by more than 150,000 homes.

Some of the significant efficiencies Ford has made challenges the MIT research, including:

- Updated heating systems at many manufacturing facilities by replacing outmoded steam powerhouses with digitally controlled direct-fired natural gas air handlers;
- Upgraded paint process systems including booth air handling and improved emission controls; and
- Continued development of a process that turns paint fumes into electricity, a painting process that significantly reduces the footprint and energy use of paint booths, and zirconium oxide pretreatment that uses less energy to inhibit surface corrosion.

The MIT figures did not include some energy costs, such as the energy required to make the materials themselves or the energy required to maintain the environment of the plant (e.g., air conditioning and filtration for clean rooms used in semiconductor processing), yet Gutowski says the team's figures are actually conservative.

MIT News explains:

> *The bottom line is that "new processes are huge users of materials and energy," [Gutowski] says. Because some of these processes are so new, "they will be optimized and improved over time," he says. But as things stand now, over the last several decades as traditional processes such as machining and casting have increasingly given way to newer ones for the production of semiconductors, MEMS and nano-materials and devices, for a given quantity of output "we have increased our energy and materials consumption by three to six orders of magnitude."*

John Engler, president of the National Association of Manufacturers, last month called developing new energy technologies to improve efficiency and reduce carbon emissions "one of our most daunting challenges."

Indeed, conserving energy and using various old and new energy sources in a sustainable way may seem like an impossible task. But today's efficient-energy investments are strategic investments, not short-term cost-cutting methods in response to rising energy prices.

Energy efficiency and conservation offer the best payback. By implementing energy-saving projects, a business or facility may be able to reduce its energy consumption dramatically — and save millions of dollars.