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Abstract: This article asserts that modern civilization depends on the wasting of energy in order to use energy. To discard energy is not always a vice. Indeed, we keep inventing new ways to waste energy and have good reason to celebrate when we do. Consider how recklessly we waste energy to produce a mere 100 watts of light--and why. A 10-watt laser beam doesn't deliver more power than the bulb or the skylight--to the contrary, it delivers less, and we waste huge amounts of ordinary light producing it. The laser burns light to generate light and tosses away most of its fuel in doing so. Casual observers are easily convinced that there must be a better way. But, in fact, this huge pyramid of consumption, with its withering losses at every turn, simply reflects, in all its real-world complexity, one of the most fundamental laws of physics: the second law of thermodynamics. The second law dictates that if the input energy is of a sufficiently low grade (a coal flame, for example), two units of it must be funneled into a machine at one end to emerge as one unit of high-grade energy at the other.

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The Virtue of Waste

A pyramid of consumption, with withering losses of energy at every turn, simply reflects the second law of thermodynamics.

To discard energy is not always a vice. It is often good. Indeed, we keep inventing new ways to waste energy and have good reason to celebrate when we do. It is only by throwing most of the energy away that we can put what's left to productive use.

Consider how recklessly we waste energy to produce a mere 100 watts of light--and why. The sun offers us 100 watts of light for free, through a couple of square feet of skylight, at noon on a moderately sunny day. Yet we pay good money for a 100-watt bulb and electrons to power it. And thousands of times more for a mere 10 watts of laser light.

A 10-watt laser beam doesn't deliver more power than the bulb or the skylight--to the contrary, it delivers less, and we waste huge amounts of ordinary light producing it. It takes big arrays of flash lamps, mounted around a large gas cavity, to stimulate the emission of the knifelike laser beam. The laser burns light to generate light and tosses away most of its fuel in doing so. But we run it anyway, because better-ordered photons packed into less space are worth far more. Sunlight feeds cows. Lightbulbs help old eyes read in dim light. A laser can delicately vaporize tissue to improve our eyesight.

The laser's miserable plug-to-beam efficiency is only the last chapter in a long saga of dissipation. Directly behind the laser stands a complex array of power electronics--a "power supply" that burns electricity to supply electricity. This tier of waste is required to convert noisy grid power into power pure enough to run the laser. The grid power is produced by a generator driven by steam from a boiler heated (most typically) by a flame from coal. In the very best power plants half the raw heat in the coal is discarded into the atmosphere. And then, at each step along the way from the power plant to the laser, energy is wasted again.

Casual observers are easily convinced that there must be a better way. But, in fact, this huge pyramid of consumption, with its withering losses at every turn, simply reflects, in all its real-world complexity, one of the most fundamental laws of physics: the second law of thermodynamics. The second law dictates that if the input energy is of a sufficiently low grade (a coal flame, for example), two units of it must be funneled into a machine at one end to emerge as one unit of high-grade energy at the other. That means one unit of input becomes entirely useless heat. Energy doesn't just lounge about waiting for the chance to propel moms and kids to football fields--getting things to that point is an uphill battle.

Only 2% of the energy that starts out in an oil pool 2 miles under the Gulf of Mexico ends up propelling 200 pounds of mom-and-the-kids--the ultimate payload--2 miles to the game. When we run an air conditioner, we dump one unit of heat into some distant power plant's cooling tower so that we can dump four more units of (unwanted) energy out of the window of our living room. It takes perhaps ten units of raw thermal energy to pump one unit of ultrareliable electricity into a microprocessor CPU and to then pump the waste heat back out.

Almost all of our demand for energy derives from energy's capacity to refine energy. It is by throwing energy overboard in this way that we maintain and increase the order of our existence. That's what the energy debate is ultimately about--very complex and subtle tradeoffs and conversions, with order rising on one side and waste heat pouring out the other. We shouldn't fool ourselves into thinking we understand it well. Nor is it useful to spend much time urging others to curtail their "consumption of order" or declare that less order--which is to say more disorder--is the only way to save the planet.

This much is certain: It is by throwing energy overboard that we maintain and increase the order of our existence. Waste, in other words, is as virtuous as order, as virtuous as a tidy room, clean dishes, plaque-free teeth, a sterile operating theater or ice in the refrigerator. You cannot get or maintain such things without dissipating energy. Life and growth being inescapably dissipative processes, waste is as virtuous as life itself.

Where Did It All Go?
Energy content in kilwatt-hours

In the beam	20
From the laser	100
From the laser drivers/coolers	200
From the power supplies	400
Used in a chip plant*	1,000
Grid electricity	2,000
Heat content from fossil fuel	6,600*

* - Pro rata share of energy consumption in factory for laser apparatus.

PHOTO (COLOR)

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By Peter Huber

Peter Huber is coauthor of The Bottomless Well: The Twilight of Fuel, The Virtue of Waste, and Why We Will Never Run Out of Energy (Basic Books, January 2005). Visit his home page at www.forbes.com/huber.

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