THE ENERGY CONCEPT

You'd probably like to be able to drive your car and light your apartment without having to pay money for gas and electricity, and if you do a little websurfing, you can easily find people who say they have the solution to your problem. This kind of scam has been around for centuries. It used to be known as a perpetual motion machine, but nowadays the con artists' preferred phrase is “free energy.”[1] A typical “free-energy” machine would be a sealed box that heats your house without needing to be plugged into a wall socket or a gas pipe. Heat comes out, but nothing goes in, and this can go on indefinitely. But an interesting thing happens if you try to check on the advertised performance of the machine. Typically, you'll find out that either the device is still in development, or it's back-ordered because so many people have already taken advantage of this Fantastic Opportunity! In a few cases, the magic box exists, but the inventor is only willing to demonstrate very small levels of heat output for short periods of time, in which case there's probably a tiny hearing-aid battery hidden in there somewhere, or some other trick.

Since nobody has ever succeeded in building a device that creates heat out of nothing, we might also wonder whether any device exists that can do the opposite, turning heat into nothing. You might think that a refrigerator was such a device, but actually your refrigerator doesn't destroy the heat in the food. What it really does is to extract some of the heat and bring it out into the room. That's why it has big radiator coils on the back, which get hot when it's in operation.

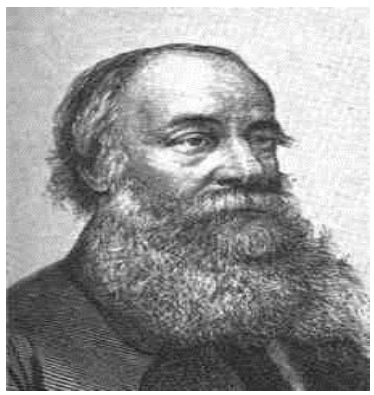

Figure a: James Joule, 1818-1889. The son of a wealthy brewer, Joule was tutored as a young man by the famous scientist John Dalton. Fascinated by electricity, he and his brother experimented by giving electric shocks to each other and to the family's servants. Joule ran the brewery as an adult, and science was merely a serious hobby. His work on energy can be traced to his attempt to build an electric motor that would replace steam engines. His ideas were not accepted at first, partly because they contradicted the widespread belief that heat was a fluid, and partly because they depended on extremely precise measurements, which had not previously been common in physics.

If it's not possible to destroy or create heat outright, then you might start to suspect that heat was a conserved quantity.

This would be a successful rule for explaining certain processes, such as the transfer of heat between a cold Martini and a room-temperature olive: if the olive loses a little heat, then the drink must gain the same amount. It would fail in general, however.

Sunlight can heat your skin, for example, and a hot lightbulb filament can cool off by emitting light. Based on these observations, we could revise our proposed conservation law, and say that there is something called heatpluslight, which is conserved. Even this, however, needs to be generalized in order to explain why you can get a painful burn playing baseball when you slide into a base. Now we could call it heatpluslightplusmotion. The word is getting pretty long, and we haven't even finished the list.

Figure b: Heat energy can be converted to light energy. Very hot objects glow visibly, and even objects that aren't so hot give off infrared light, a color of light that lies beyond the red end of the visible rainbow. This photo was made with a special camera that records infrared light. The man's warm skin emits quite a bit of infrared light energy, while his hair, at a lower temperature, emits less.

Rather than making the word longer and longer, physicists have hijacked the word “energy” from ordinary usage, and give it a new, specific technical meaning. Just as the Parisian platinum-iridium kilogram defines a specific unit of mass, we need to pick something that defines a definite unit of energy. The metric unit of energy is the joule (J), and we'll define it as the amount of energy required to heat 0.24 grams of water from 20 to 21 degrees Celsius. (Don't memorize the numbers.)[2]

Note how only *differences* in temperature and energy appeared in the preceding example. In other words, we don't have to make any assumptions about whether there is a temperature at which all an object's heat energy is removed. Historically, the energy and temperature units were invented before it was shown that there is such a temperature, called absolute zero. There is a scale of temperature, the Kelvin scale, in which the unit of temperature is the same as the Celsius degree, but the zero point is defined as absolute zero. But as long as we only deal with temperature differences, it doesn't matter whether we use Kelvin or Celsius. Likewise, as long as we deal with differences in heat energy, we don't normally have to worry about the total amount of heat energy the object has. In standard physics terminology, “heat” is used only to refer to differences, while the total amount is called the object's “thermal energy.” This distinction is often ignored by scientists in casual speech, and in this book I'll usually use “heat” for either quantity.

We're defining energy by adding up things from a list, which we lengthen as needed: heat, light, motion, etc. One objection to this approach is aesthetic: physicists tend to regard complication as a synonym for ugliness. If we have to keep on adding more and more forms of energy to our laundry list, then it's starting to sound like energy is distressingly complicated. Luckily it turns out that energy is simpler than it seems. Many forms of energy that are apparently unrelated turn out to be manifestations of a small number of forms at the atomic level.

Source:
http://physwiki.ucdavis.edu/Fundamentals/02._Conservation_of_Energy/2.1_Energy