Heat-Powered Engines (Thermal to Mechanical Conversion)

You lose some energy every time you either convert it from one form to another, or store it and retrieve it. For this reason it is best to use energy directly whenever possible. If there is water to be pumped for instance, the mechanical energy from wind is best used directly, rather than being converted first to electricity and then running an electric motor to pump the water.

Modern electrical generators (typically alternators) and motors can be quite efficient. They typically convert between electrical and mechanical energy at rates better than 90%.

Converting heat energy into mechanical energy however, is a different matter. A French physicist named Carnot developed a formula that gives the maximum efficiency available for a heat engine. Although the steam engine was the target of his work, his formula works for any form of heat engine: The maximum efficiency possible from any heat engine can be calculated by subtracting the exhaust temperature from the maximum temperature, and dividing this difference by the maximum temperature – the maximum temperature being degrees above absolute zero. In simple arithmetic terms this would be written as (tmax-tmin)/tmax.

Compressing gas increases the temperature, and expanding it cools it. Standard automotive engines rarely have compression ratios greater than about 9 to 1. The temperatures during combustion are thus allowed to expand and cool as the piston travels downward. The efficiency of such engines is typically about 20%, although it can exceed 30% under ideal loading and RPM. Diesel engines however, with compression ratios often exceeding 20 to 1, can have efficiencies of 40% and higher.

Of all the various build-it-yourself offerings that have filled books and videos over the years, none have fascinated me as much as mechanical energy. If a person had a technique for converting THERMAL energy into mechanical energy, he could:

- Produce his own electricity at his own convenience,
- Power a heat pump for heating his home,
- Produce cooking temperatures from electricity, a specially built heat pump, or a combination of the two,
- Run air conditioning.

To summarize, a sustainable energy system could consist of (a) One or more energy sources designed to produce heat from whatever energy sources were available in the area, (b) At least one thermal storage unit (an additional unit might even be designed to store the more efficient high temperatures, if an appropriate energy source was available), and (c)A means of converting the stored thermal energy into mechanical energy.

Such technology would be to the development of alternative infrastructures as the steam engine was to the industrial revolution.

The reason I emphasize THERMAL to mechanical conversion is because any form of energy that you might have can be converted into heat. This would of course include wind power, water power, methane, solar, firewood, buffalo chips, junk mail, and obsolete utility bills.

Another reason is for the sake of energy storage. There are few more simple or economical techniques for storing large amounts of energy than heating something in an insulated container. Contrast this with the complexity and environmentally-destructive materials used in battery technologies.   This really came home to me one time as I was reading about a then high-tech battery that used molten lithium salt. When it occurred to me to calculate the energy stored in the heat alone, I found it to exceed the electrical capacity of the battery!

A further design challenge would be to come up with an engine that could operate on a relatively low temperature difference. Now I recognize that a low temperature difference means low efficiency, but it also increases your options for energy sources.