

The energy content of 1 gallon of oxygenated automobile gasoline (U.S. Department of Energy, Energy Information Administration, Annual Energy Review 2002 [DOE/EIA-0384(2002), October 2003], Appendix A: Thermal Conversion Factors¹) is

$$\frac{5.150 \times 10^6 \text{ BTU}}{\text{barrel}} \cdot \frac{1055.9 \text{ Joule}}{\text{BTU}} \cdot \frac{1 \text{ barrel}}{42 \text{ gallons}} \cdot \frac{1 \text{ Watt} \cdot \text{second}}{\text{Joule}} \cdot \frac{1 \text{ hour}}{3600 \text{ seconds}} = 35,960 \frac{\text{Wh}}{\text{gallon}}$$

or 35,960 Watt-hours per gallon of gas. A gas engine with a very good efficiency of 30% will extract only about 10,800 Wh of energy out of that gallon of gas.

Now let's say that a regenerative braking system shows you that it has recovered 50 Wh of energy (one green leaf-car on the Prius). Let's also say that this recovered energy is delivered with 80% efficiency to move the car with an electric motor. The 50 Wh of recovered energy then gives you the equivalent propulsive energy of about $(0.8)(50)/(10,800) = .0037$ gallons of gas utilized, or about 1 tablespoon.

The kinetic energy of a Prius traveling at 60 miles per hour (curb weight 2890 pounds, plus 300 pounds cargo) is

$$\begin{aligned} \frac{1}{2}mv^2 &= \frac{1}{2} (3190 \text{ pounds}) \left(60 \frac{\text{miles}}{\text{hour}}\right)^2 \cdot \frac{1 \text{ kg}}{2.205 \text{ pound}} \cdot \left(\frac{5280 \cdot 12 \text{ inches}}{\text{mile}}\right)^2 \\ &\quad \cdot \left(\frac{.0254 \text{ meters}}{\text{inch}}\right)^2 \cdot \left(\frac{\text{hour}}{3600 \text{ seconds}}\right)^2 \\ &= 520,400 \text{ Joules} \cdot \frac{1 \text{ Watt} \cdot \text{second}}{\text{Joule}} \cdot \frac{\text{hour}}{3600 \text{ second}} = 145 \text{ Wh} \end{aligned}$$

The Prius regenerative braking system is far from 100% efficient in recovering this energy; otherwise you would see three 50 Wh "green leaf-cars" every time you stopped from 60 miles per hour.

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¹<http://www.eia.doe.gov/emeu/aer/pdf/03842002.pdf>

²<http://xray1.physics.sunysb.edu/jacobsen/>