The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

List of Foods by Environmental Impact and Energy Efficiency

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This is a guest post by Praveen Ghanta, known on The Oil Drum as praveen. Praveen is an IT consultant in Atlanta, with degrees in economics and computer science. This was originally posted on Praveen's blog, truecostblog.com.

Which foods have the smallest (and largest) energy footprint, thereby having the most environmental impact? While most people probably realize that meat products have a larger energy and environmental impact, the degree of difference isn't immediately clear. How much difference does it make if you're a vegetarian, or if you're almost entirely carnivorous? The following list provides a rough estimate of the energy required to produce different kinds of foods, in order from least to most energy intensive. David McKay's Without The Hot Air is a source for many of the numbers below:

Table 1: List of Foods By Energy Required to Produce One Pound

Food	Energy (kWh) to Produce 1 Lb
Corn [1]	0.43
Milk [2]	0.75
Apples [3]	1.67
Eggs [4]	4
Chicken [5]	4.4
Cheese [2]	6.75
Pork [6]	12.6
Beef [7]	31.5

Table 2: Energy Efficiency of Various Foods (Measured as Food Calories / Energy Used in Production) [8]

Food	Calories / Lb	Energy Efficiency
Corn	390	102%
Milk	291	45%
Cheese	1824	31%
Eggs	650	19%
Apples	216	15%
Chicken	573	15%

Pork	480	8.5%
Beef	1176	4.3%

The data above indicate the huge difference in energy required from one end of the food spectrum to the other. Roughly twenty-five times more energy is required to produce one calorie of beef than to produce one calorie of corn for human consumption. Dairy products are actually fairly energy efficient, as they are very dense in calories. Vegans may indeed be able to boast that their diets use 90% less energy than the average American's, and even those who eat only eggs and dairy can lay claim to significant energy efficiency.

At the same time, food production and consumption amounts to only about 10% of first-world energy consumption, so even the most parsimonious eater can reduce their total energy footprint by around 9% through diet alone. The big culprits remain transportation, heating, and cooling, and while diet modification can help, energy conservation efforts should focus most heavily on these areas.

[1] It's possible to estimate the energy involved in corn production very accurately, since corn energy intensity has been closely scrutinized by both proponents and critics of the corn ethanol industry. This Berkeley study compares energy intensity estimates from two sources, one pro and one anti-ethanol. Using an average of the two studies' data yields an estimate of 30,000 BTU energy consumed per gallon of ethanol produced. From the same study, about 2.75 gallons of ethanol are produced per bushel of corn, which means that one bushel of corn required 82,500 BTU. One bushel of corn is 56 pounds of corn kernels, so one pound of corn kernels requires 1473 BTU for production. This is equivalent to 0.43 kWh.

[2] For milk, the estimates provided in Without The Hot Air Chapter 13 are utilized, with this conversion used for fluid ounces of milk to weight. The estimates for cheese are also taken from the above chapter, with the numbers simply proportionally adjusted from kg to pounds.

[3] From Table 3 in this study in Nature, we see that the annual energy input for a hectare of apple trees is 500,000 MJ, or 56,230 kWh at 3.6 MJ per kWh and 2.47 acres per hectare. According to this article, 800 bushels of apples per acre appears normal, which is 33600 lb of apples at 42 lb of apples per bushel. This equals 1.67 kWh per pound of apples.

[4] Here are the estimates for eggs, taken from Without The Hot Air page 77. Using a standard of eight eggs to a pound, convert from metric to English measures and arrive at the 4kWh estimate.

[5] Chicken is examined in detail on Without The Hot Air page 79, and I use that estimate, converted to kWh per pound.

[6] For Pork, I use McKay's estimates from page 77, and convert them for each animal. McKay estimates that a 65kg human burns 3kWh per day, or 0.0462 kWh / kg / day = 0.021 kWh / pound / day. McKay uses a pig lifespan of 400 days, and thus notes that if you want to eat a pound of pork every day, 400 lb of pig must be alive at any given time (one pound for each day, so that the rate of pig production matches the rate of consumption). McKay further estimates that only two-thirds of an animal can be used for meat, so we actually need 600 lb of pig to generate one pound of meat per day. 600lb * 1 day * 0.021 kWh / pound /day = 12.6 kWh for a pound of pork.

[7] Beef is calculated exactly as for Pork above, except that a cow lives for 1000 days instead of 400 days. 1000 lb / 0.66 (wastage factor) * 1 day * 0.021 kWh / pound / day = 31.5 kWh for a pound of beef.

[8] Calorie data was taken from caloriecount.about.com, and kcal (food calories) were converted to kWh for energy efficiency calcs. We simply convert the calories in one pound of each food into kWh, and then divide that number by the energy required for production of one pound of that food.

[9] How can corn have an energy efficiency higher than 100%? This means that the energy that human beings put into the process of growing, distributing, and eating corn is less than the energy provided to the human body by the corn. The hidden factor here is sunlight – corn plants are drawing energy from the sun for free, and storing that energy, which humans later consume.