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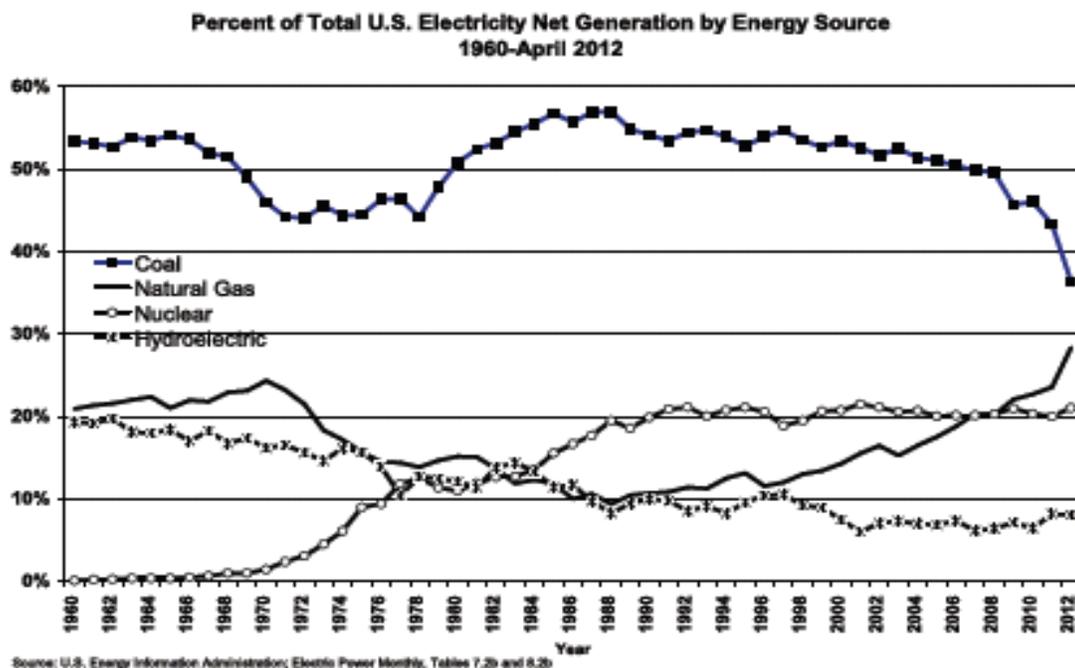
Answers to questions you may not even know you have.

Shale Gas: An Environmental Perspective

This essay was originally published in 2012. Ron—investment manager, engineer, farmer, and landowner—compares the carbon content of various energy sources and the number of acres of land needed by each one to produce the fuel to generate enough electricity to serve 1,000 households for one year.

We begin with the assumption that people want to heat their homes and cook their food, which means they want access to energy of some kind. This paper explores the choices we have between various sources of energy. We look at the sources today and in the near future from an availability, cost, and environmental standpoint. This study is not complete—and is not meant to be—as various factors are always changing. We do believe, however, it can serve as a useful benchmark.

FIGURE 1



Today, availability of energy is led by electricity and gasoline, followed closely in most areas by natural gas (methane), diesel, and propane. Coal and wood are not as readily available to the average homeowner as they used to be. Electricity is not a primary source of energy—it is really a delivery mechanism. As of April 2012, the primary sources of energy to generate electricity (Figure 1 above) are coal (36%); natural gas (28%); nuclear (21%); and hydroelectric (9%), with some help from wind, and solar. (Wind and solar are available, but only on an intermittent basis.)

Over the last 5 years, while nuclear has been stable at approximately 20%, coal has dropped from over 50% to 35%, and natural gas has increased from 20% to 29 percent. As a result of these changes, total U.S. carbon dioxide emissions from energy consumption are down 14% from their peak in 2007.

Environmentally, hydrogen is viewed as being more environmentally friendly than carbon. Figure 2 (below) shows the chemical composition of various energy sources in terms of their carbon/hydrogen makeup. In addition, different sources have various negative side effects which we broadly label pollution.

FIGURE 2

Common Name	Chemical Composition	%Carbon	% Hydrogen
Coal	Several	>50	<50
Wood	Several	>35	<65
Diesel Fuel	C ₁₆ H ₃₄	32	68
Gasoline	C ₈ H ₁₈	31	69
Propane	C ₃ H ₈	27	73
Ethanol	C ₂ H ₆ O	25	75
Methane	CH ₄	20	80
Hydro	-----	0	0
Nuclear	-----	0	0
Wind	-----	0	0
Solar	-----	0	0

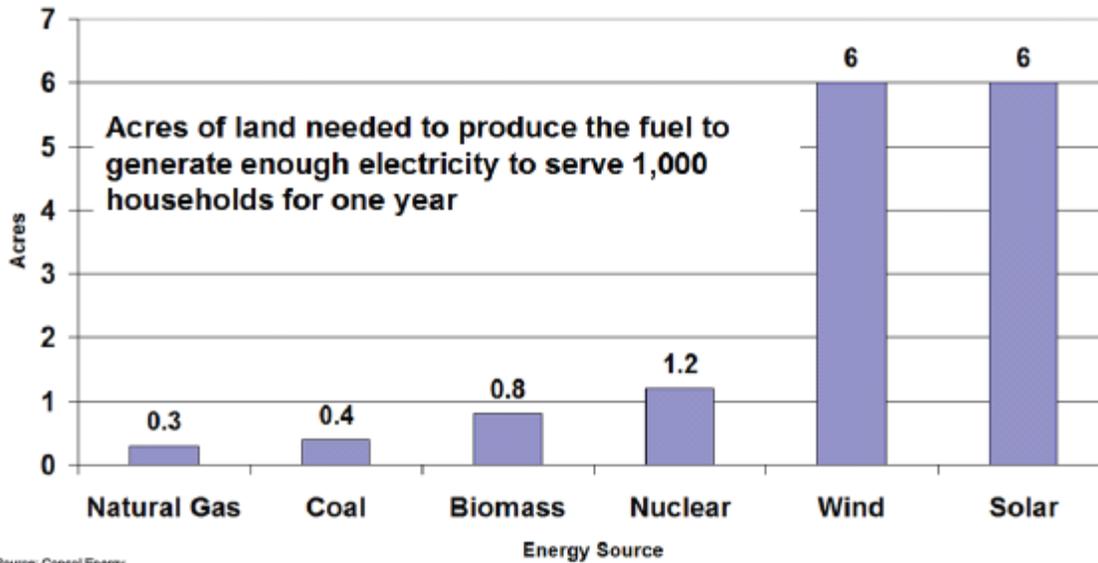
Source: Muhlenkamp & Company, Inc.

Pollution includes the various “dirty” aspects of coal, wood, and diesel. It also includes the carbon monoxide output from burning gasoline, the effects from hydroelectric dams on fish, and the impact on birds from wind turbines and large scale solar. Other “side effects” include the land areas required for wind and solar panels (see Figure 3 below), and the prodigious amounts of water required for ethanol production; (refer to my essay titled *Shale Gas versus Ethanol: A Water Perspective* available at www.muhlenkamp.com).



FIGURE 3

Land Usage: Favors Natural Gas for Power Generation



In terms of cost of energy, the relationship among coal, natural gas, and nuclear that seemed stable five years ago has been dramatically altered by recent technological advances in rock drilling and fracturing. These advances have increased the supply and decreased the costs of natural gas.

The early beneficiaries of these decreased costs have been landowners and companies skilled in the new technology. The benefits have expanded to homeowners who heat with natural gas (refer to my previous paper on *How Shale Gas Benefits the Consumer*), and users of electricity. Within the next three to five years, the benefits are likely to extend to current users of gasoline, propane, and diesel fuel. And this is just the beginning.

The comments made by Ron Muhlenkamp are his opinion and are not intended to be investment advice or a forecast of future events.

