

## Basic Energy Concepts

Energy sustainability is immensely complex. It interfaces with geopolitical, environmental, and economic issues, creating problems for which there are many answers, all unsatisfactory in one way or another. A series of white papers follow that focus first on a broad understanding of energy in general and then on individual sources of energy. Policy possibilities will be discussed after the basic facts are reviewed.

1. Energy Sources. The primary sources of energy are the hydrocarbons—coal (26% of world energy production), natural gas (23%), and oil (38%)<sup>i</sup>. From oil comes gasoline, liquid petroleum gas (LPG), fuel oil, and feedstock for the petrochemical industry. Hydrocarbon sources of energy can be stored and used in many ways for many purposes. Additional sources of energy include nuclear (6% of world production), hydroelectric (6%), wind, solar, and geothermal (together 1%)<sup>i</sup>. These additional sources of energy are all means to generate electricity and are more difficult to use for other purposes. Electricity can be used for a variety of purposes, but it cannot be stored in significant amounts. One final category is biofuels. Like hydrocarbons, they can be stored and used for various purposes, but unlike hydrocarbons, they derive from living plants, not “fossilized” ones.<sup>ii</sup>

2. Energy Uses. The uses to which energy is put are usually divided into the following categories: industrial (33% of U.S. consumption), transportation (28%), residential (21%), and commercial (18%)<sup>iii</sup>. Electrical generation is the largest category of consumption, but it is not an end use; the energy is passed to the other uses. Not usually included in discussions of energy consumption, but a significant use of oil nonetheless, is the petrochemical industry. Most plastics are derived from oil.

3. Getting Energy. To obtain energy, one must first locate an energy resource. Then one must develop a method to extract the energy. For coal and nuclear, this means mining it. For oil and gas it means drilling and pumping. For hydroelectric, it means building dams or wave & tidal energy projects. For solar and wind, it means building lots of solar panels and wind turbines. Once extracted, the energy resource requires processing (sometimes extensive) before it can be used as a source of energy. It must be transported to the processing facility, and then it must be distributed to users. All of these steps are capital intensive. Some of them use energy as part of the refining process and/or in order to build the energy extraction, collection, processing, and distribution systems. Each step is inefficient, with significant energy lost to the atmosphere as heat. These several energy losses are significant in combination, and constitute an offset against the energy collected from the source. The higher the offset, the lower the net energy yield from the resource.<sup>ii</sup>

4. Energy Dependence. Our industrialized, suburbanized way of living was born with the discovery that coal could be used to power industrial processes. We are dependent on the availability of concentrated forms of energy that can be used to sustain this way of living. Current energy sources are all highly problematic—they are at risk to run out, they are poisonous, or they cause climate change. We are likely to be forced to move away from our current patterns of energy use whether we want to or not. Finding an adaptive way to do so is a challenge on which we need to be working hard.<sup>ii</sup>

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<sup>i</sup> *International energy review, 2004*. U.S. Energy Information Administration

<sup>ii</sup> Nersesian, Roy. (2007). *Energy for the 21<sup>st</sup> Century*. Armonk, NY: M.E. Sharpe.

<sup>iii</sup> *Annual energy review, 2006*. U.S. Energy Information Administration.