EROI for an energy source is a key indicator of its contribution to maintenance of social and economic complexity.

Net-energy availability has varied tremendously over time and in different societies. In the last advanced societies that relied only on solar power (sun, water power, biomass, and the animals that depended on biomass), in the seventeenth and early-eighteenth centuries, the amount of net energy available was low and dependent largely on the food surpluses provided by farmers. At that time, only 10 to 15 percent of the population was *not* involved in energy production. As extraction of coal, oil, and natural gas increased in the nineteenth and twentieth centuries, society was increasingly able to substitute the energy from fossil fuels for manual or animal labor, thereby freeing an even larger proportion of society from direct involvement in energy production. In 1870, 70 percent of the U.S. population were farmers; today the figure is less than 2 percent, and every aspect of agricultural production now relies heavily on petroleum or natural gas. The same is true in other energy sectors: Currently, less than 0.5 percent of the U.S. labor force (about 710,000 people) is directly involved in coal mining, oil and gas extraction, petroleum refining, pipeline transport, and power generation, transmission, and distribution.

The challenge of a transition to alternative energy, then, is whether such energy surpluses can be sustained, and thus whether the type of social and economic specialization we enjoy today can be maintained. Indeed, one study estimates that the minimum EROI for the maintenance of industrial society is 5:1, suggesting that no more than 20 percent of social and economic resources can be dedicated to the production of energy without undermining the structure of industrial society.[11]

In general, most alternative energy sources have low EROI values (see Figure 3). Because of their high energy-input requirements, biofuels produce very little or no energy surplus.[12] Similarly, tar sands provide less than 3 units of energy for each unit consumed. In contrast, wind energy shows a high return on energy investment, but it is subject to the problems of intermittency and siting issues.

A high EROI is not sufficient to ensure that the structure of modern society and economies can be maintained, but it is a prerequisite. Unfortunately, EROI is not well understood or routinely used in energy analyses by government or industry, despite the insights it can provide. Because of the enormous investment in resources and energy that any alternative energy pathway will require, it is important that we look beyond simple financial payback, particularly in a future of rising energy prices, declining fossil-fuel resources, and increasing danger of climate catastrophe.

HOW WILL SOCIETY EVOLVE IN A POST-CARBON WORLD?

Alternative energy forms are crucial for a global transition away from fossil fuels, despite the myriad challenges of their development, scaling, and integration. In face of the peaking of global oil production—to be followed by peaks in natural gas and coal extraction—and of the need to reverse trajectory in carbon emissions, alternative energy sources will need to form the backbone of a future energy system.

That system, however, will not be a facsimile of the system we have today based on continuous uninterrupted supply growing to meet whatever demand is placed on it. As we move away from the energy bounty provided by fossil fuels, we will become increasingly reliant on tapping the current flow of energy from the sun (wind, solar) and on new energy manufacturing processes that will require ever larger consumption of resources (biofuels, other manufactured liquids, batteries). What kind of society we can build on this foundation is unclear, but it will most likely require us to pay more attention to controls on energy demand to accommodate the limitations of our future energy supply. Moreover, the modern focus on centralized production and distribution may be hard to maintain, since local conditions will become increasingly important in determining the feasibility of alternative energy production.